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FIRE CONTROL NOTES

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A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 11 234768 Number 1

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The periodical is printed with the approval of the Bureau of the Budget as required by Rule 42 of the Joint Committee on Printing.

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1950

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THE HUDSON BAY HIGH AND THE SPRING FIRE SEASON IN THE LAKE STATES

MARK J. SCHROEDER

Fire Weather Official, U. S. Weather Bureau

INTRODUCTION

What causes periods of critical burning conditions in the Lake States? Are these critical periods associated with any particular weather types? If so, what weather types are generally associated with critical periods in the spring? In the summer? In the fall? The answers to these questions would be of considerable help to a fire-weather forecaster in the Lake States, especially in attempting to arrive at a longer range forecast of impending critical burning conditions.

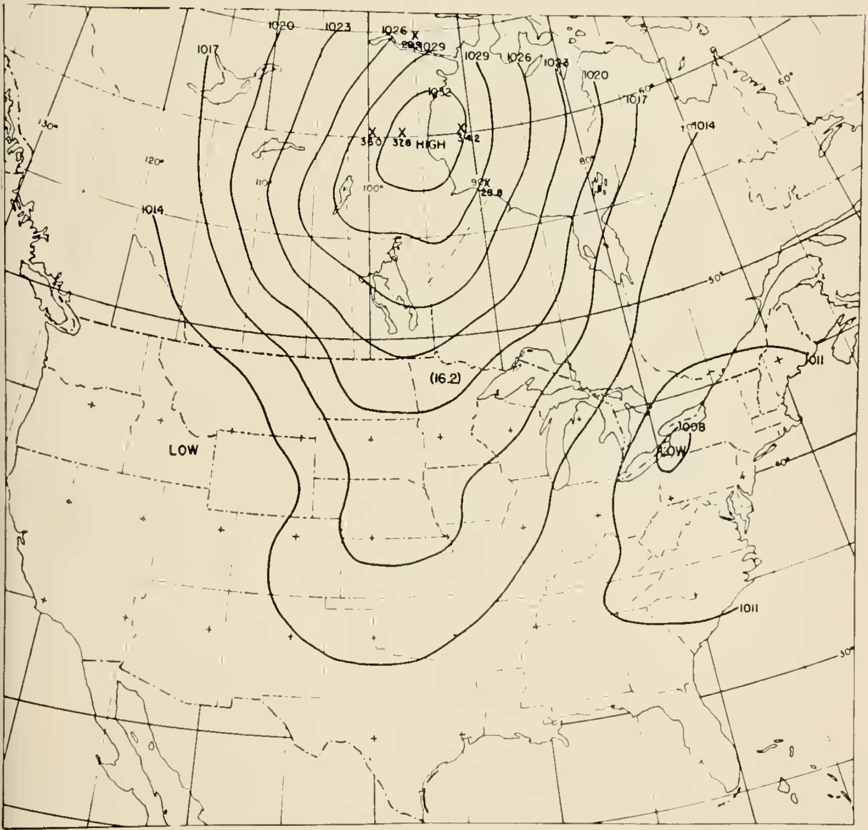

FIGURE 1.—Composite map of the Minnesota cases 2 days prior to the first day of very high burning index. The 6:30 a. m. maps for May 2 and 16, 1946, May 7, 1947, and May 7 and 22, 1948, were used. The location and central pressures of the individual highs are indicated.

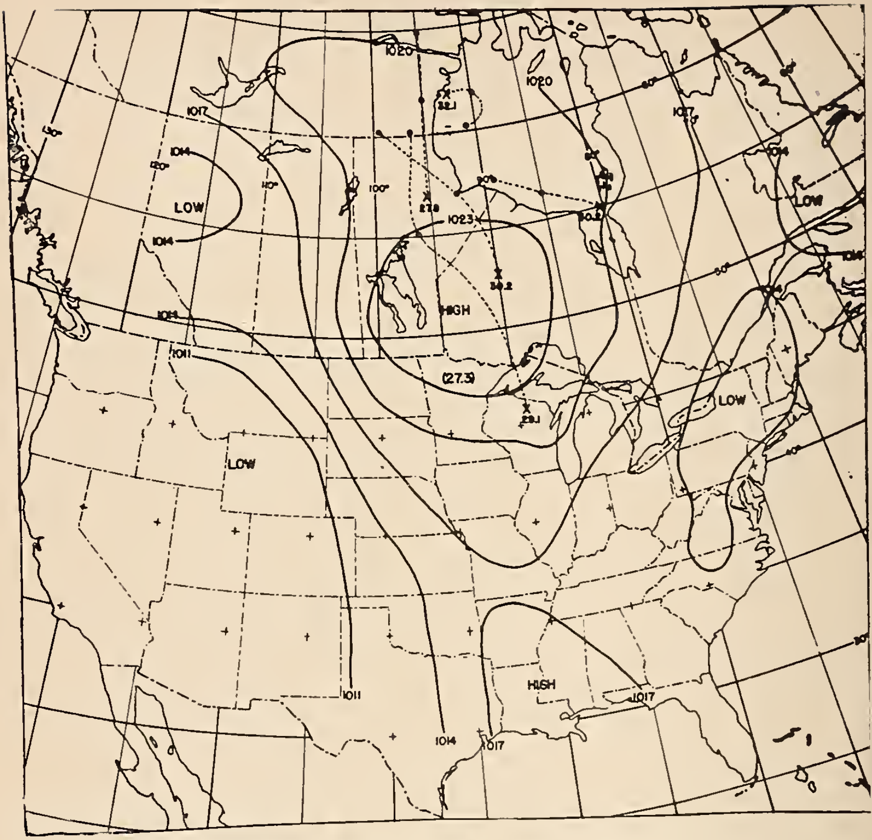

Figure 2.—Composite map of the Minnesota cases on the first day of very high burning index. Past daily positions of the individual highs are shown by dots and their paths by dashed lines.

Not all of the above questions are answered here. In this study an examination of the spring burning index records and associated weather was undertaken. It is expected that studies of the summer and fall seasons will be made at a later date.

METHOD

In the Lake States a 0–100 scale of burning index is used which is divided as follows:

safe	0–1
very low	2–3
low	4–6
moderate	7–12
high	13–24
very high	25–49
extreme	50–100

The periods of critical burning conditions for each State were determined by simply averaging the highest burning index reported each day by each of the fire-weather stations. This was done for the spring fire seasons of the years 1945–48. A State average of more than 24 (very high) was considered critical.

The spring fire season in the Lake States normally extends from the 1st of April through the 31st of May. Since only one period of very

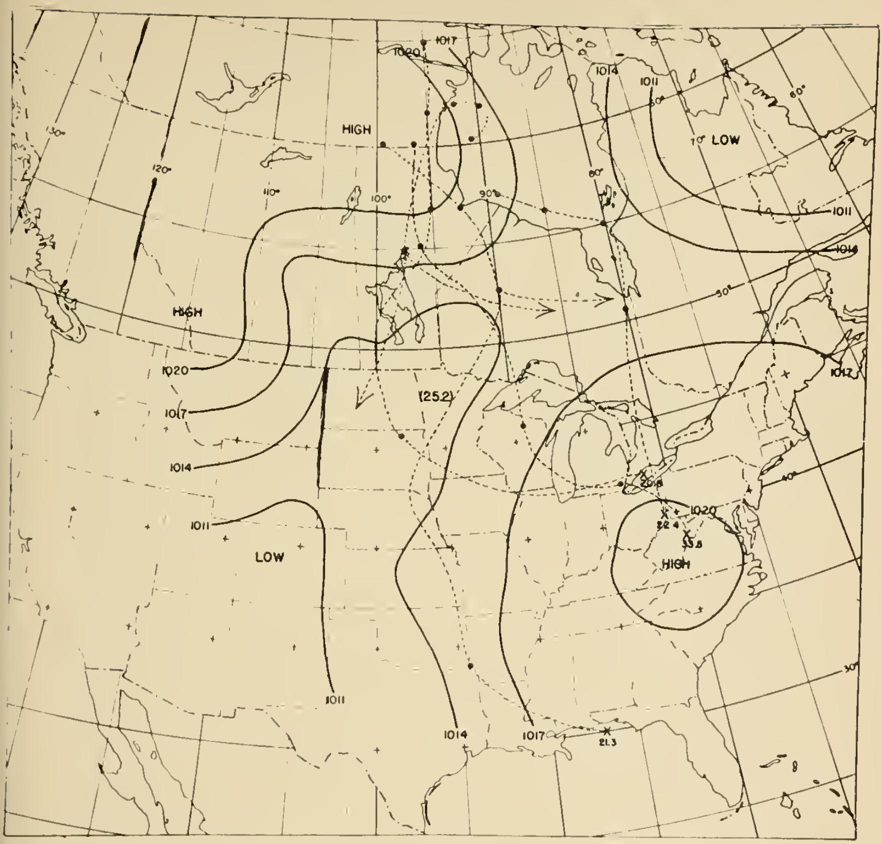

Figure 3.—Composite map of the Minnesota cases 2 days after the first day of very high burning index. Paths and daily positions are shown as in figure 2.

high burning index occurred during the month of April, not justifying a study of weather types, only the month of May was considered further. There were five May periods of very high burning index in Minnesota, eight in Wisconsin, six in Upper Michigan, and four in Lower Michigan.

A study of the weather maps during these critical periods showed a similarity between most of the weather situations. To bring out this similarity, composite maps of the similar cases were made by averaging the sea-level pressures at each of a large number of weather stations in the United States and Canada and drawing isobars (lines through points of equal pressure) for these average pressures.

DISCUSSION OF RESULTS

Nearly all of the critical periods were associated with an area of high pressure (hereafter called a "high") which developed near the western shore of Hudson Bay and subsequently moved either southward or southeastward. A slow-moving high that develops or intensifies in the Hudson Bay region is frequently referred to as a "Hudson Bay High." All of the periods of very high burning index in Minnesota and Upper and Lower Michigan were associated with that weather type, as were seven of the eight periods in Wisconsin.

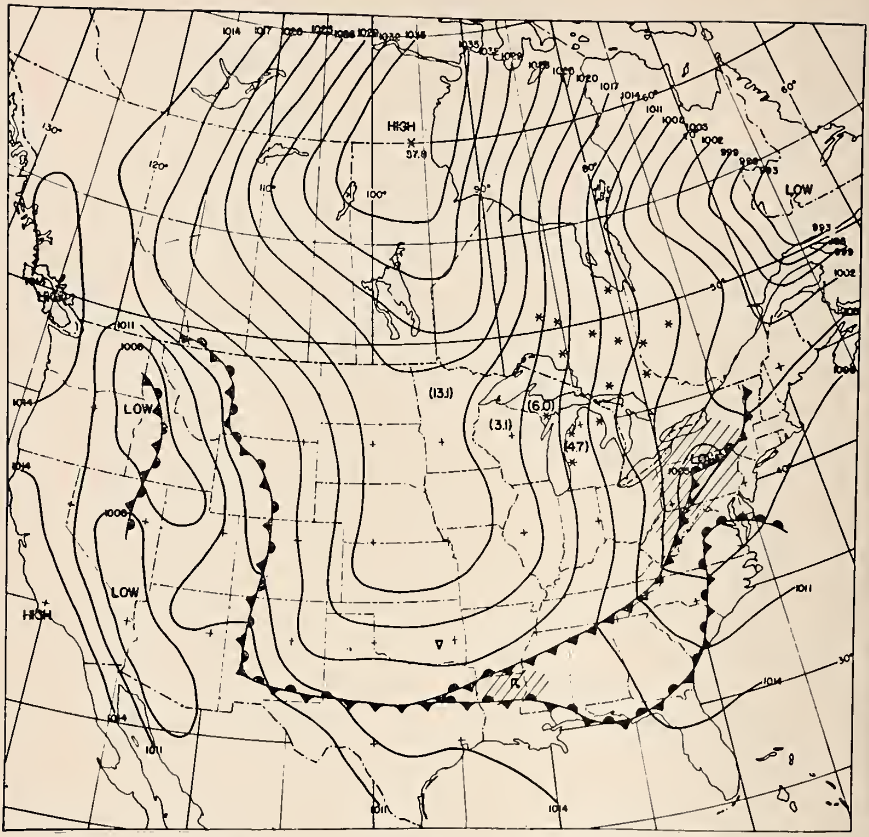

Figure 4.—Surface map for 6:30 a. m. May 7, 1947. The average burning index in each of the Lake States is shown by the figure in parentheses. Stars indicate snow and hatched areas are areas of more or less continuous precipitation.

The one Wisconsin period which was different, and the one April case that was found, were associated with highs that moved from western Canada through the Lake States in a southeasterly direction.

It was interesting to note that there was no case in May of the years studied in which a Hudson Bay high moved southward or south-southeastward from the Hudson Bay region, that was not associated with a period of very high burning index in Wisconsin.

Composite maps shown in figures 1 through 3 show definitely that the Hudson Bay type is associated with critical burning conditions in the Lake States in May. Figure 1 is a composite sea-level map for 6:30 a. m., 2 days before the first day of very high burning index for the Minnesota cases. Figure 2 is a composite map on the morning of the first day of very high burning index, and figure 3 is one for 2 days later. The first of this series shows a rather intense high located on the west shore of Hudson Bay with a ridge of high pressure extending southward through the Plains States: a very dry situation for Minnesota and usually Wisconsin and Upper Michigan. The burning index at this time is already high over Minnesota (16.2), and at some stations very high, but the average over the State does not become very high until 2 days later. By then (fig. 2) the high center has

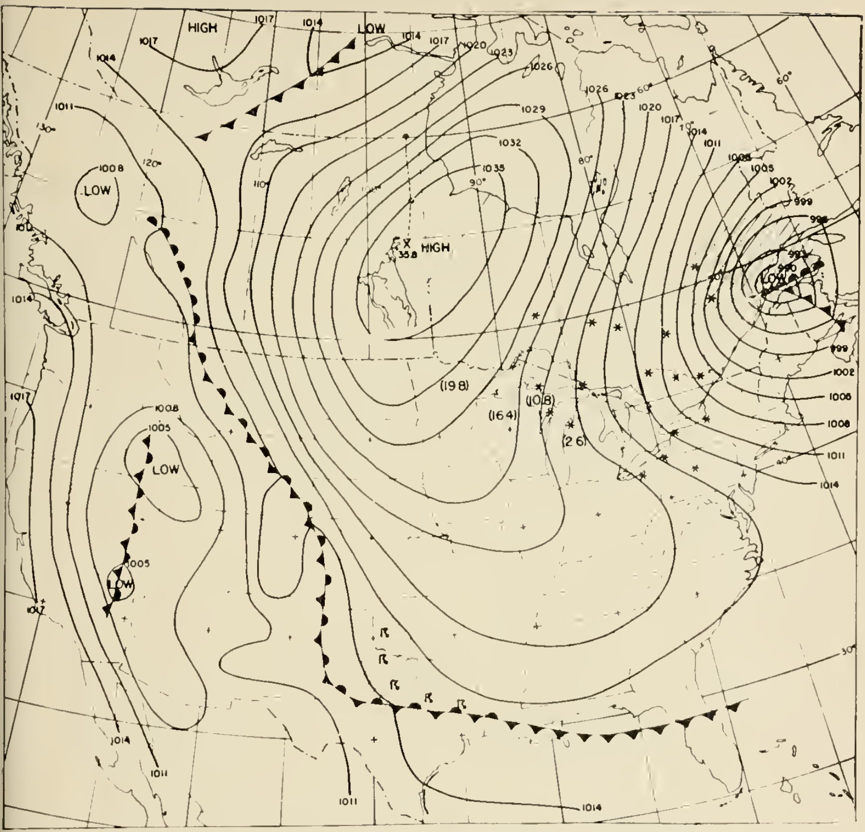

FIGURE 5.—Surface map for 6:30 a. m. May 8, 1947. Past 12-hourly positions of the Hudson Bay high are shown by dots and its path by a dashed line.

moved southward to extreme western Ontario. The high pressure ridge has moved eastward to the Mississippi Valley and has built southward to the Gulf coast. Two days later (fig. 3) the high center has moved to the middle Atlantic coast and diminished in intensity, while lower pressure has moved into the northern plains. The burning index in Minnesota is still very high, but is about to be reduced by rainfall.

Similar composite maps (not shown) for the seven Wisconsin cases of very high burning index were drawn and show generally the same pattern. No composite maps were drawn for the critical periods in Upper and Lower Michigan. Since each of these periods occurred with a weather situation that also produced a critical period in Wisconsin, there is no doubt that a similar pattern would result.

The length of the critical periods in Minnesota ranged from 1 to 6 days with an average of 3½. In Wisconsin the range was from 1 to 5 days with an average of 3, in Upper Michigan 1 to 3 days with an average of 2, and in lower Michigan 1 to 6 days with an average of 3. Usually the period of very high burning index associated with a single Hudson Bay high was 2 to 3 days. During longer periods an additional high passed through or near the Lake States. The second one was either another of the Hudson Bay type or one from northwestern Canada moving southeastward. What usually happened in these

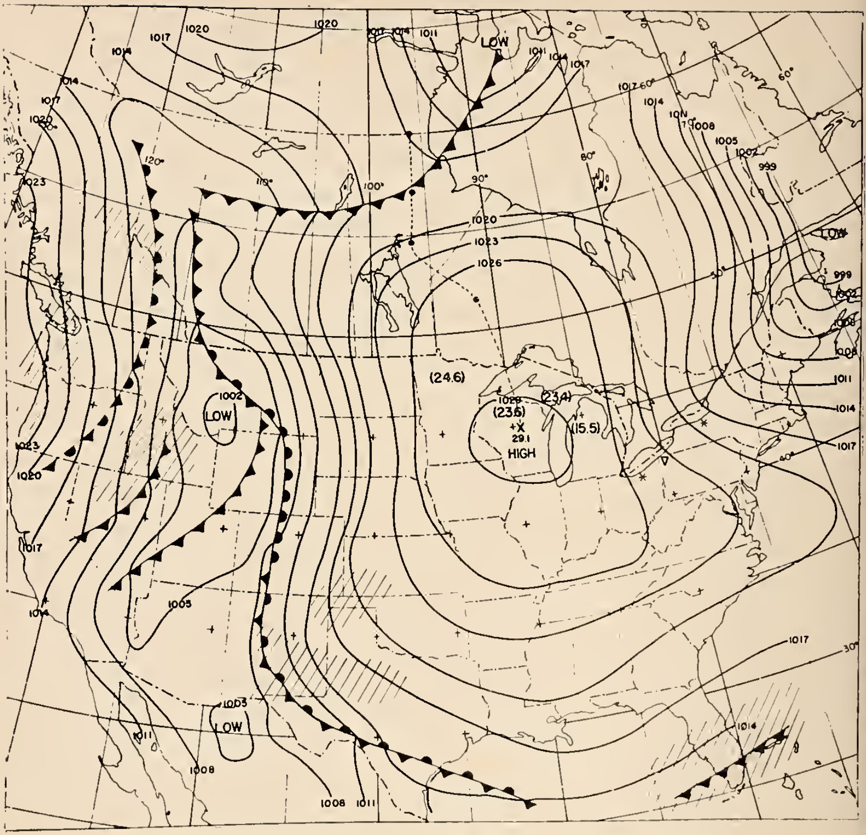

Figure 6.—Surface map for 6:30 a. m. May 9, 1947.

cases was that the precipitation following the Hudson Bay high did not cover all of the Lake States, and in the areas where none occurred the burning index remained very high during the passage of the next high.

Previous studies have shown that Hudson Bay highs are more frequent during the month of May than any other month; also that their mean path has a more southerly direction in May than in April. This may account for more periods of very high burning index being found in the Lake States during May than during April.

TYPICAL CASE

A typical weather sequence involving a Hudson Bay high is shown in the 6:30 a. m. sea-level maps for May 7–11, 1947, reproduced in figures 4–8. This weather sequence was chosen because it was associated with a period of very high burning index in each of the Lake States.

On the first day of this sequence the average burning index in Minnesota was already high (13.1); the fire-weather stations in that State having been without measurable precipitation for 3 to 5 days. Stations in Wisconsin and Upper Michigan had been without precipitation for 1 to 4 days, and in Lower Michigan 1 to 3 days. Measurable precipitation was reported at some stations in Lower Michigan as late as the morning of the 8th.

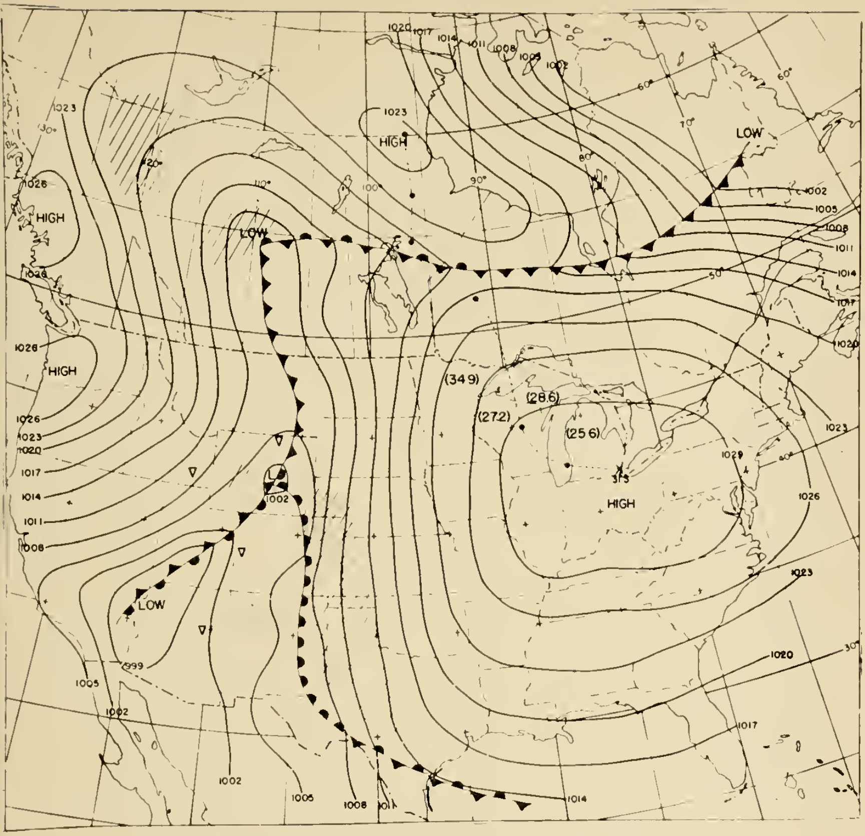

Figure 7.—Surface map for 6:30 a. m. May 10, 1947.

As the high moved southward on the 8th, the relative humidities in Minnesota and northwestern Wisconsin lowered; noontime readings being generally in the 20's and 30's in these areas. When the center of the high moved to Wisconsin on the 9th, humidities lowered considerably in both Upper and Lower Michigan and the rest of Wisconsin, being under 20 percent at several stations at the noon reading. The burning index increased correspondingly, reaching the very high classification in Minnesota.

The winds became predominantly southwesterly on the 10th and increased in velocity in Minnesota, Wisconsin, and Upper Michigan, while the humidities changed little or increased slightly. (Winds blow in a clockwise direction around a high with a slight cross-isobar component from high to low pressure. The wind velocity is inversely proportional to the spacing of the isobars; that is, the closer together the isobars, the stronger the wind.) The burning index then rose still more, becoming very high in all of the Lake States. It should be noted that the average burning index in Lower Michigan rose from low to very high in only 2 days.

A trough of low pressure began to move into northwestern Minnesota on the 11th as the high moved southeastward to the Virginias. Dry conditions still prevailed in Wisconsin, Lower Michigan, and portions of Minnesota, but rain at some stations in Upper Michigan and

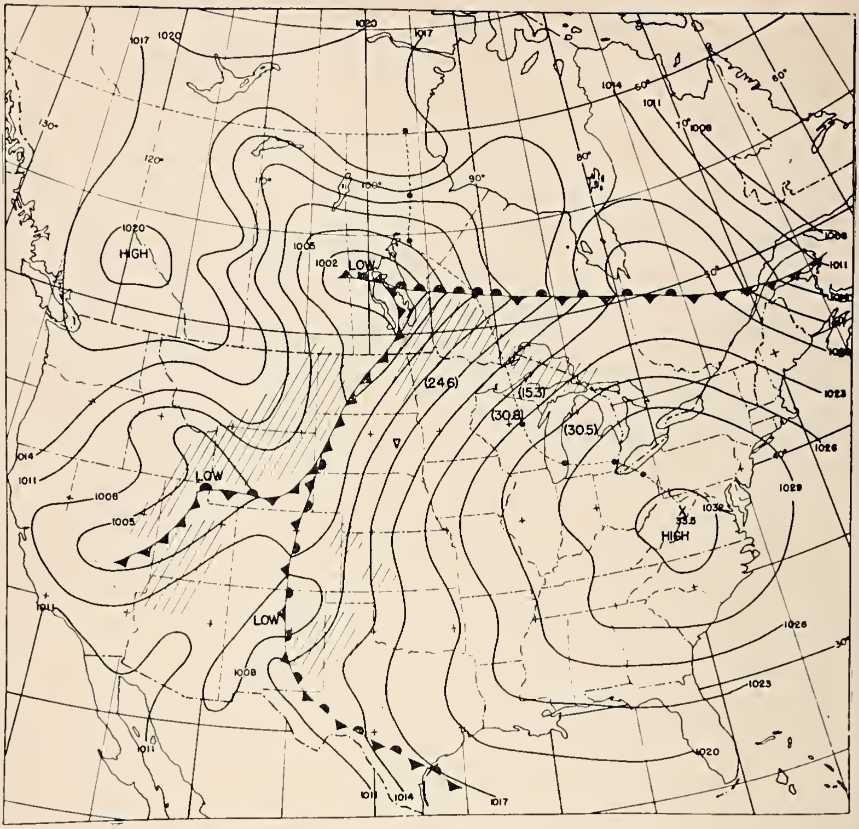

Figure 8.—Surface map for 6:30 a. m. May 11, 1947.

Minnesota diminished the average burning index in those two areas. Rain finally reduced the burning index to the low classification, or lower, in Minnesota and Upper Michigan on the 12th and in Wisconsin and Lower Michigan on the 13th (maps not shown).

It is interesting to note the similarity between this typical situation and the composite maps for the Minnesota cases by comparing figures 1, 2, and 3 with figures 4, 6, and 8.

CONCLUSION

This study suggests that the Hudson Bay high is the principal weather type associated with periods of very high burning index in the Lake States in May, although other situations may occur. It is not reasonable to conclude, however, that critical burning conditions associated with Hudson Bay highs do not occur in April.

Knowing the relationship between the Hudson Bay high and the burning index should be an aid in producing longer-range fire-weather forecasts of impending critical burning conditions in the Lake States. The accuracy of the forecasts, however, will be contingent upon the forecaster's ability to foretell the development and movement of the Hudson Bay high.

CHEMICALS FOR FIRE PREVENTION

Alva G. Neuns
California Forest and Range Experiment Station

Propaganda alone will not prevent man-caused fires. Active prevention aimed at fireproofing rights-of-way and other areas of concentrated use is often a greater need.

Annual grasses and weeds are commonly the fuels most susceptible to fire on such areas in many forest regions. Their removal is frequently the only practical way to prevent fires. Hand grubbing, power scraping, burning, cultivating, and spraying with petroleum oils are among the methods used to get rid of fuels. Too often the effects are not what they should be. High costs and the need for annual retreatment result in sporadic and incomplete results. In the search for a cheaper and more permanent method, chemical treatment has been tried and found to be the answer in many cases.

Annual fireproofing is necessary when a regrowth of plant cover must be encouraged each year to hold the soil in place during periods of heavy rains. The objective of chemical treatment is to reduce the yearly cost. Sodium chlorate and polybor-chlorate are used for annual treatment. Long-time sterilization may be used where soil can safely be maintained bare of vegetation. Arsenic trioxide, R. C. A., and Borascu will prevent growth of plant cover for several years and are therefore economical to use.

Sodium chlorate.—Sodium chlorate in water solution is an effective spray for killing annual grasses and weeds. It is quick-acting and comparatively low in cost. It should be applied after heavy rains are over and the need for plant cover is no longer critical. The fireproofing job should be complete, however, before the dry season in order to meet the prevention need. Its sterilizing effects are temporary because it will leach from the soil during the rains preceding the following growing season.

One-half to one pound of sodium chlorate per gallon of water will give complete kill of most weeds and grasses. Heavier dosages saturating lower stems and the ground may be used to kill shrubs and perennial weeds. Some easy to kill species may call for a weaker mixture. Enough solution should be sprayed with enough force on the foliage to thoroughly wet the leaves and stems. Power spray equipment is generally used. The cost of sodium chlorate in California is $107.50 per ton or approximately $5.37 per hundred pounds. Prices may differ in other areas.

Because sodium chlorate is highly combustible when applied to organic material, it should never be used immediately preceding or during periods of high fire danger. Risk to men and equipment through the use of chlorate can be almost wholly overcome by observing strict rules for storing, handling, and applying. The following points from Purdue University Extension mimeograph No. 1 should be kept in mind:

Precautions (when in contact with organic matter sodium chlorate creates a fire hazard):

1. Store sodium chlorate in tightly closed metal containers.
2. Do not spill sodium chlorate in automobiles, trucks, or in buildings.
3. Avoid using sodium chlorate near buildings. On such areas, remove all vegetation and apply material on the soil to reduce fire hazard.
4. Do not allow clothing to become saturated with sodium chlorate solution.
5. Wear rubber boots when applying sodium chlorate.
6. Keep sodium chlorate out of reach of livestock. Do not pasture treated areas until the plants have dried or the material has been washed into the soil by heavy rains.

Hundreds of tons of sodium chlorate are used each year on hundreds of miles of roadside strips and for large scale noxious weed control in California. This demonstrates that it can be used successfully. There have been cases of improper use in dry periods following very light fall rains. A few years ago several fires in southern California apparently were started when passing cars rubbed against roadside weeds sprayed with sodium chlorate. Fortunately, these are rare and can be avoided if good judgment is used in choosing time of application.

Polybor-chlorate.—Polybor-chlorate was developed to eliminate the fire hazard associated with chlorate for use in places where rainfall is very low, dry seasons are long, and fire danger continuously high. Its manufacturers claim a killing strength equal to chlorate when sprayed on foliage in a mixture of 1½ pounds per gallon of water. Although its sterilizing effect on the soil has not been observed past the first year, it is not expected to differ from chlorate. Possible disadvantages include a slightly higher cost ($140 per ton in California) and a poisoning effect on citrus trees because of the addition of boron.

Arsenic trioxide.—Arsenic trioxide (usually called white arsenic) is known to have caused soils to remain sterile for periods of 10 years or longer. Wherever erosion is not a problem and the soil can remain undisturbed after treatment, effects are long-lasting. Treatment should be limited on most soils to slopes under 25 percent. Steeper slopes may be treated if the soil is very stable. White arsenic is usually applied after all annual growth has been cleaned from the area to be treated. The chemical is easily applied in dry powder form by hand or with spreaders at the rate of 4 pounds per square rod on most soils. Coarse sand and heavy red clays require more. It should be put on during the rainy season or set down afterward to prevent wind loss.

The cost in California is 6 to 8 cents per pound. Labor and transportation costs are low owing to the small quantities needed to produce long-lasting effects. Even though white arsenic is a poison, it is not hazardous if reasonable care is used in handling and storing. It does not attract game or wildlife and is therefore not a hazard to them.

A good example of the use of white arsenic is to be seen on the Shasta National Forest. It was applied in April 1940 to bulldozed and hand-cleared fire lines. Forest officers cooperated with the Southern Pacific Company on a project to fireproof their railroad right-of-way. In 1948, 100-percent sterilization was still in effect (fig. 1).

R. C. A. (*razorite concentrate anhydrous*).—R. C. A., or razorite, is a boron ore in granular form which is often used when white arsenic is not available or for some reason cannot be used. Applied by hand or spreaders at the rate of 25 pounds per square rod, it is equal to arsenic trioxide as a soil sterilant. Because R. C. A. is somewhat water-soluble, however, its effects are less permanent; depending on the amount of annual rainfall, it will leach from the soil in 3 to 5 years. Because of its granular form R. C. A. may have some disadvantage where wind loss is a problem.

The cost of $60 per ton, large volume of material to be handled, and the less permanent results make it a more expensive material to use.

Borascu.—Borascu, an unrefined boron ore in granular form, similar to R. C. A., is also widely used. The cost is $35 per ton, but its soil sterilizing strength is only half that of R. C. A., and therefore twice as much material must be applied to do the same job. It may be more readily available than R. C. A. or white arsenic in some areas.

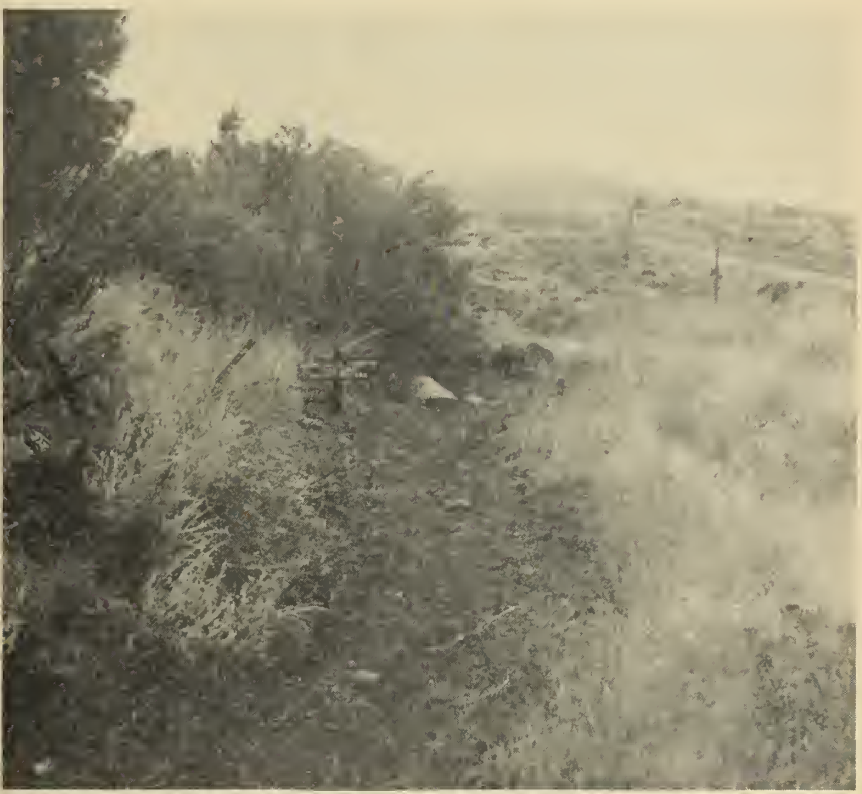

FIGURE 1.—Fire line along railroad right-of-way 8 years after treatment with arsenic trioxide.

FIRE PUMPER TESTING AND DEVELOPMENT

Arcadia Fire Control Equipment Development Center

Region 5, U. S. Forest Service

A continuing project at the equipment development center is pumper testing. Not only are pumps tested as to compliance with specifications, but also any new developments and designs in pumper units that give promise of possible use to the Forest Service are given short test runs. The purpose of the program is to insure that pumpers offered as meeting specifications are adequate for Service needs and that new developments in equipment are immediately available.

Pumpers purchased under existing Forest Service specifications are required to have passed an approval test including a 100-hour operating test. The 100 hours in actual practice represents the approximate operating time that many units are used during a fire season. In effect, it insures that a pumper put into service can be expected to at least perform at rated output and pressure during a season without need of repairs.

Another Forest Service specification requirement tested is that pumps under normal operating conditions should require only 80 percent of the horsepower output of the driving engine when operating at sea level. This requirement is important since the average gasoline engine decreases in horsepower output approximately 3 percent for each 1,000 feet above sea level. We are thus assured that pumpers will operate at rated output up to elevations of 7,000 feet without overloading the engine. Under operating conditions below this elevation, the engine not being operated at peak output can be expected to have a longer service life.

The main equipment used in the tests are recording flow meters, pressure meters, and vacuum meters, which are operated in parallel with indicating gages of the same types. All equipment is calibrated preceding each test run and the purpose of dual instrumentation is to insure that any failure in meters will be immediately apparent and corrected. The complete description of testing equipment and procedure of the tests has been covered in a Pumper Test Procedure Report, which is available at the Development Center.[1] A general view of the test stand is shown in figure 1. The equipment is used, not only to check pumpers, but also to test hose, strainers, nozzles, and any other equipment through which water flows.

Before starting the 100-hour pumper test, a series of runs are made to give data regarding the output of the unit under pressure ranges from free discharge to the maximum pressure obtainable. Runs under varying suction lifts are also made to show the ability of the unit when drafting. This same series of tests is performed at the conclusion of the 100-hour run and the comparison of values before and after are an indication of wear and decrease in efficiency. Units are checked before and afterward for clearances and, if efficiency drops to any great extent, are completely dismantled and checked against manufacturer's specified tolerances.

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[1] Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 Santa Anita Ave., Arcadia, Calif.

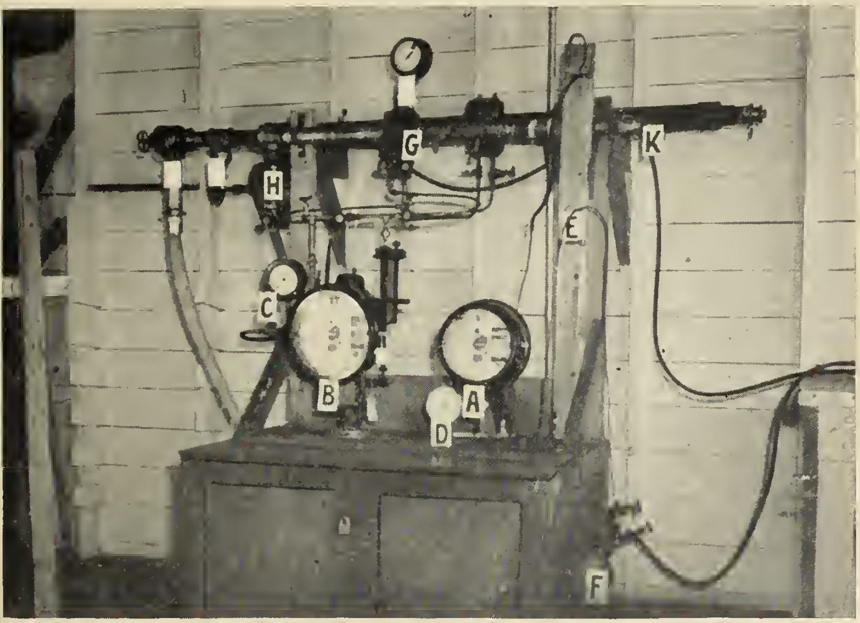

FIGURE 1.—Pumper testing equipment: *A*, Draft (vacuum) recorder; *B*, discharge pressure and rate recorder; *C*, discharge pressure gage; *D*, draft (vacuum) gage; *E*, draft gage (mercury manometer); *F*, hand-operated priming or vacuum pump; *G*, orifice meter piping; *H*, discharge pressure (back pressure) regulator; *K*, intake connection to orifice meter piping.

In performing the 100-hour test, units are run intermittently for the first 50 hours and continuously for the final 50 hours. During intermittent operation, items such as ease of starting, and procedure of starting are noted. The final period is used as an indication of the unit's ability to perform over long periods.

Other pertinent details, such as adequacy of design, fuel consumption, and general suitability for the varying needs of the Service are checked.

In checking new pump designs only the tests that are normally run as preliminary to the 100-hour test are performed. This is usually sufficient to provide proper data that indicates whether or not the unit warrants further investigation.

Many interesting facts have been brought to light as the result of the pumper tests. Of two units submitted by different manufacturers, the volume of water pumped by both was in excess of that which could be efficiently handled by the factory recommended suction and discharge hoses. An increase to the next larger hose size on the suction side increased the volume of water pumped by approximately 10 percent. On the discharge side, an increase to the next larger hose size reduced pressure drop by approximately 90 percent. One unit was redesigned for a lower volume and higher pressure, and on subsequent tests, performed adequately. A change was made in the inlet and outlet fittings of the second unit, which allowed for the use of the next larger size of hose.

Of two other units tested for the same manufacturer, the first by actual weight was 60 percent lighter than the second one and had an output at the same rated pressure approximately 35 percent less. However, the efficiency of the pump and engine was such that when compared with all accessories and with sufficient fuel for 24 hours of operation, the units had approximately the same over-all weight. This indicates that over-all weight for a given operating period, and not weight of the pumper only, should be considered when deciding on what type of equipment is to be used.

To date three units have been 100-hour tested. Two more units are scheduled and will be completed in the near future. The pressure volume rating for the three units mentioned above are as follows:

Pressure (pounds per square inch)	*Volume discharge in gallons per minute*		
	Pump A	*Pump B*	*Pump C*
0 (free discharge)	24	42	18
100	22	39	17
250	18	30	10
310	16	25	--

Complete specifications have been written, under which approximately 85 pumps of the above sizes have been purchased and placed in field operation.

Approximately 10 additional units have been spot-checked. Of these, two merit further study and, after redesign, will again be submitted by the manufacturers.

Fire Guard Improvises Antenna for Handi-Talkie on Project Fire.—The following story is quoted from a letter by Supervisor Kooch of the Salmon Forest, regarding use of Handi-talkie by Ranger Alternate J. G. Denny.

"Our first chance to try out the new Handi-talkie, Forest Service type FS sets, on this district was on the Dutch Oven Fire, with three of the sets in strategic positions on the fire and one on an observation point. They certainly worked beautifully.

"While on mop up on this fire we had two Handi-talkies for communication on the fire and also for communication with the dispatcher in Salmon via Long Tom Lookout.

"We had moved our camp to a more suitable location and somewhere in the shuffle we lost the antenna for one of our Handi-talkies. I experimented with a length of No. 9 telephone wire inserted in the antenna socket. I could send and receive all right but the wire was so loose in the socket that it caused a great amount of static.

"Through inquiry at camp I discovered a short length of antenna from an automobile radio, and a stove bolt of the desired size. By fastening the stove bolt to the antenna with a gob of solder, I had an improvised antenna that would transmit and receive at a distance of more than 10 miles.

"The little Handi-talkie is the answer to a fire fighter's prayer."—Francis W. Woods, *Communications Engineer, Region 4, U. S. Forest Service.*

A NEW MEASURE OF THE SEVERITY OF FIRE SEASONS

A. W. Lindenmuth, Jr., *Forester, Fire Research, Southeastern Forest Experiment Station*, and J. J. Keetch, *Danger Station Inspector, Region 7, U. S. Forest Service*

A new method for expressing the severity of fire seasons in terms of number of fires is now being tried in the Northeast. The number-of-fire rating is computed from a weighted risk factor which is derived by relating the actual occurrence to the burning index measured at fire-danger stations. Thus, when the computed risk factor is held constant, the fluctuations in number of fires are in direct proportion to changes in fire danger. The actual risk does not usually remain constant, of course, since every fire control agency is working to reduce it. Also, intermittent strikes or a sudden increase in forest visitors, as during hunting season in bad fire weather for example, increase the normal risk for short periods. The actual occurrence, therefore, is not necessarily in direct proportion to the expected occurrence, which is based on season rating. It will be so only if the risk remains constant. The difference between actual and expected fires, or the ratio of one to the other, is meaningful as a guide in determining whether an unusual number of fires is primarily due to a change in risk or a particularly bad or easy fire season.

The accuracy of the new technique has not as yet been fully determined. While the burning index scale on meters 5–W and 5–O was intentionally made directly proportional to average fire occurrence in the Northeast, this relationship had not been thoroughly tested. Several years of records will be needed to define the limits of error. Certain improvements in the integration of the measurements may be necessary. At the present time, however, the method for rating fire seasons outlined here gives fire administrators a useful tool to weigh trends in fire occurrence.

As an illustration, when the number of fires in a district drops year by year from a high of 334 to a low of 88, something has happened—but what? Have fire seasons been successively easier, or has a particularly effective prevention campaign been waged.

This reduction has occurred in a flatwoods protection unit of one of the seaboard eastern States. The situation is illustrated in graph *A*, figure 1. The solid line shows the steady reduction in man-caused fires from 334 to 88 over a period of 5 years. The dashed line shows the expected number of fires, or the season ratings, for the same period. In the lower half of the graph the stippled area shows the trend in fire occurrence, or the proportional relationship between the actual fire occurrence and the season rating. The ratio is determined by dividing the actual number of fires by the season rating.

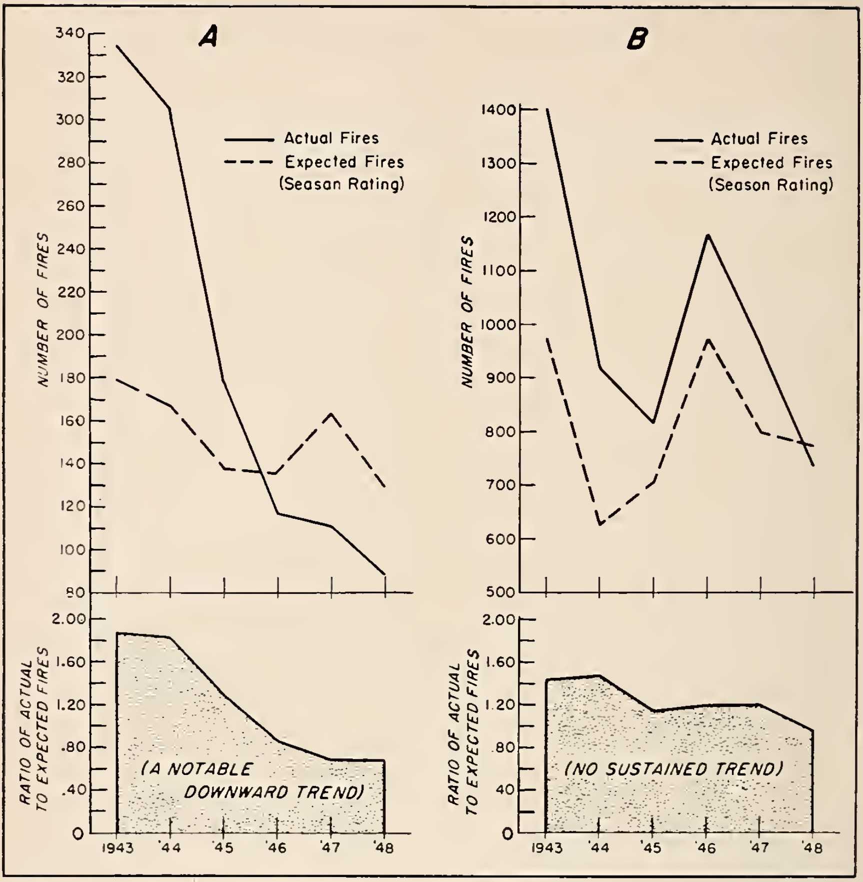

Figure 1.—*A*, An efficient prevention campaign reduced fire occurrence more than measured fire danger would have indicated. *B*, The lack of any major trend in fire occurrence indicates that the actual number of fires was controlled chiefly by the weather.

In graph *A* the actual number of fires was reduced more each year than measured conditions normally warranted. This reduction did not happen by chance. It was caused by a well-planned, sustained fire prevention campaign carried on during the 5 years.

Graph *B* indicates a different situation in a different area. Here the lack of any major trend in fire occurrence (in relation to the season rating) means that the actual number of fires was controlled chiefly by weather. This is particularly true of the sharp reductions in fire occurrence during 1944 and 1947 as well as the big increase during 1946. This does not imply that no efforts were made to reduce the number of fires. A prevention program was carried on; however, no major change in emphasis was made in the program during the period. So this is an example of what one would normally expect if there is no notable shift in fire risk or prevention efforts.

Graphs *A* and *B* illustrate the new method which helps to explain the reasons for changes in number of fires and shows up trends in fire occurrence. It can be used to measure the effectiveness of prevention campaigns, to help fire administrators estimate the number of fires which should have occurred in any period, and to establish annual or periodic fire control objectives. One of its apparent advantages is that it substantiates the benefits of good work.

In order to draw valid conclusions from season ratings regarding trends or patterns of fire occurrence, the ratings must be based upon measured values. In this method, the season rating is determined by measured fire danger, preferably as integrated by the type 5–W or type 5–O meters.[1] These meters carry burning index scales of from 1 to 100 which were intentionally made directly proportional to the number of man-caused fires in the Northeast. This means, for instance, that as the burning index doubles, the number of man-caused fires, on the average, also doubles. Thus, the number of fires by years on a particular unit should vary as the sum of the indexes for the same period, so long as the area protected remains the same. If that does not hold true, one may logically conclude that either the degree of human risk or the habits of the fire-starting agents have changed.

However, if one wants to compare the severity of fire seasons between different units, a mere comparison of the sum of the burning indexes is not sufficient. When two or more units enter into a comparison, there are differences in area, population, fuel types, topography, attitudes, and habits of the people, and many other things besides the weather factors. These many overlapping factors affecting fire occurrence must be properly weighted.

Weighting can be accomplished and comparisons among units made possible by converting burning indexes for each unit into expected number of fires for a month, season, or year, as desired.

This conversion from burning index to expected number of fires is effected in this method by:

1. Calculating a risk factor for each month during the 5-year period 1943–47 by dividing the number of fires each month by the sum of the daily burning indexes for that month.

2. Choosing for each month the 3 years having the lowest risk factor. For example, in May the risk factors by years might be as follows:

Year:	*Fires*	*Burning index*	*Risk factor*
1943	39	291	0.1340
1944	43	392	.1097
*1945	18	206	.0874
*1946	4	65	.0615
*1947	16	406	.0394

The three years marked with asterisks would thus be selected.

3. For each month summing the number of fires and burning indexes for the three selected years and dividing one by the other to obtain a weighted average risk factor. Thus from step 2 the factor would be 38 divided by 677, or 0.0561.

4. For each month of the year to be rated, multiplying the weighted average risk factors by the burning indexes. The sum of monthly ratings is the year rating.

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[1] Distributed by the Southeastern Forest Experiment Station for use in the Northeastern States and the mountainous sections of the Southeast.

In the foregoing the average of the three lowest years was selected as a rating base because that seemed a reasonable objective. Obviously, an average of the 5 years or any single year could have been used.

The method can be applied not only to individual protection units, but also to national forests, States, regions, or even larger areas. Ratings for these can readily be built up by adding together the ratings from all of the individual units included. As a result, this method may be used in any area, regardless of size, where fire occurrence can be related to measured fire danger.

Examples of composite ratings for larger areas are shown in figure 2 by a second pair of graphs. Graph *C* presents the data for an eastern State, graph *D* an eastern national forest. These particular examples are chosen because they show a difference in the trend of fire occurrence. In the case of the State (graph *C*) a steady reduction in the number of actual fires over and above what one would expect is indicated, whereas on the national forest (graph *D*) no particular trend is indicated; the actual number of fires sometimes is greater and sometimes is less than the season rating.

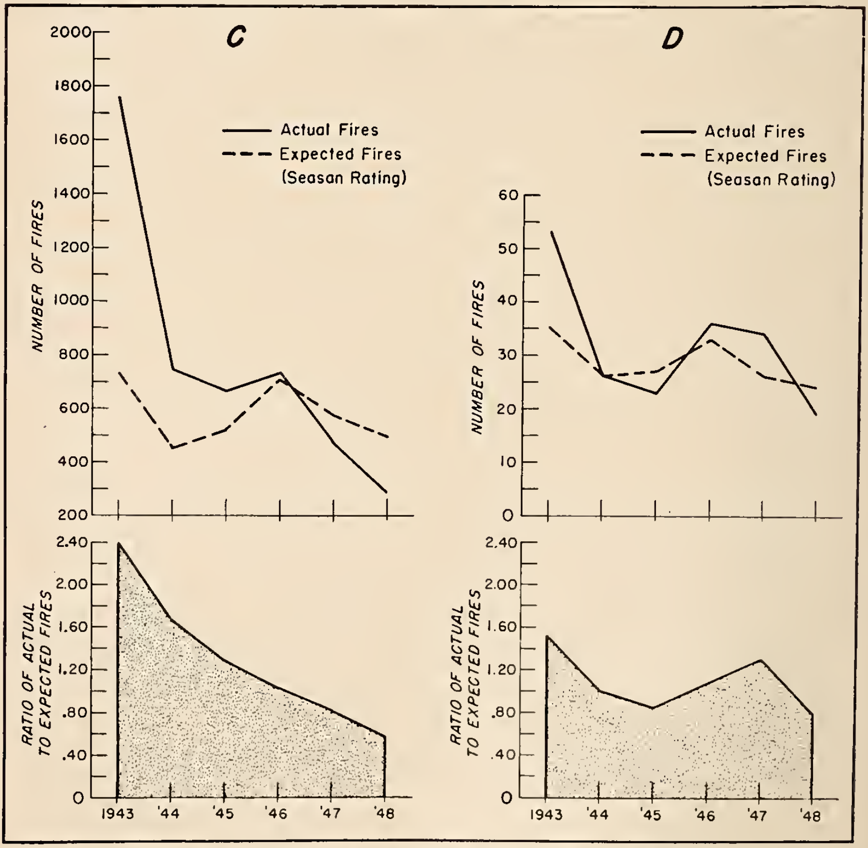

Figure 2.—*C*, Debris burning laws and enforcement were effective in reducing fire occurrence in this eastern State. *D*, Records from an eastern national forest show what may be expected when there is no outstanding change in fire risk or prevention efforts.

The reduction in number of fires in the State has been steady and continuous for the past 5 years. The decline started with the passage of legislation restricting debris burning, which was the major cause of forest fires in this State, and the downward trend has been sustained by active enforcement of the law. From these data it appears that the efforts have been highly successful in reducing the number of wild fires. However, since the number of fires has already been reduced from 240 percent of the season rating to only 56 percent of the number expected according to measured fire danger, the downward trend may soon be arrested; the ratio between the actual number of fires and the expected number may remain relatively constant in the future. That would indicate that either a practical minimum in the number of fires has been reached or a change in emphasis must be made in the prevention program in order to reduce the number of fires originating from causes other than debris burning.

Perhaps the national forest used as the example may have already reached the point where further reductions in number of fires can only be made by very specialized prevention efforts. Whether or not this is true can only be determined by the responsible administrative officers. The data, however, point up the fact that there is no marked trend either toward a reduction or an increase in the actual number of fires over and above the season rating.

Of course, the State or national forest ratings do not tell the whole story, since by comparison some of the districts may not have made as much progress in reducing the number of fires as the others. The method reported here, in addition to pointing out regional or sectional trends, should be helpful in aiding administrative officers to focus attention on troublesome units and periods. Then specific problems can be isolated and attacked.

Wet water.—Studies on use of wetting agents, under way at Pilgrim Creek in Shasta National Forest, are emphasizing two facts. One is that increased efficiency through use of wet water under field conditions depends on using proper equipment and techniques of application. Another, perhaps equally important, is that a great deal of improvement in use of plain water might be realized through study of application techniques.

The men working with W. L. Fons on this project spent 6 weeks developing equipment and techniques in field use. These tests paid off. The men are now collecting data on comparisons of wet and plain water. So far, they have measured as much as 2 to 1 superiority for wet water; that is, only half as much water was needed with wetting agents and proper techniques.

Laboratory work had promised improved efficiency with wet water; but before methods of application and necessary experimental controls were worked out, wet and plain water appeared about equal in field use. Now wet water leads, and plain water has been used more efficiently.—*Staff Notes, California Forest and Range Experiment Station, 9–13–49.*

EFFECT OF LITTER TYPE UPON FUEL-MOISTURE INDICATOR STICK VALUES

W. L. Fons and C. M. Countryman

California Forest and Range Experiment Station [1]

Instructions for establishing fire-weather stations in Region 5 have usually specified that the fuel-moisture indicator sticks be placed over a bed of ponderosa pine needles. This specification was made to insure uniform ground-cover effect for all stations. Because ponderosa pine needles are not readily available in all areas of California, fire control technicians have often asked if pine needles must be used in preference to local litter types.

To answer this question, the effect of litter type on fuel-moisture indicator stick values was measured as part of other litter studies at the Shasta Experimental Forest. Eight common types of litter were used: (1) ponderosa pine needles (*Pinus ponderosa*), (2) California black oak leaves (*Quercus kellogii*), (3) snowbrush leaves (*Ceanothus velutinus*), (4) manzanita leaves (*Arctostaphylos* spp.), (5) white fir needles (*Abies concolor*), (6) bitterbrush leaves (*Purshia tridentata*), (7) mixed conifer needles (including white fir, ponderosa pine, sugar pine, incense cedar), (8) cured grass.

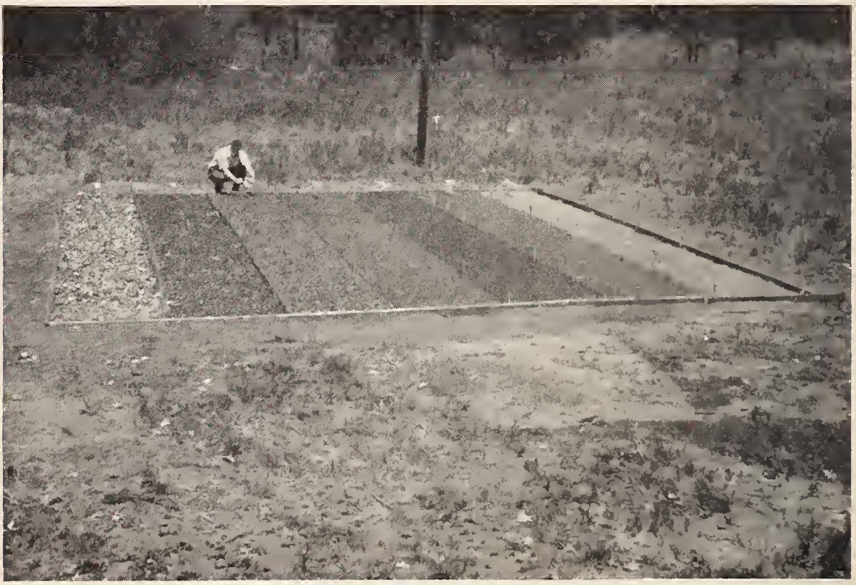

Figure 1.—Litter beds used in fuel-moisture studies at the Shasta Experimental Forest. Litter types from left to right are: Oak, snowbrush, manzanita, white fir, bitterbrush, mixed conifer, grass. The ponderosa pine litter bed (not shown) is a few feet to the left of the oak litter bed.

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[1] Maintained by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of California, Berkley, Calif.

Beds 3 feet wide, 30 feet long, and 3 inches deep were prepared for each kind of litter. A fuel-moisture stick was exposed 10 inches above each bed on wire supports (fig. 1). The sticks were weighed to the nearest 0.1 gram on a torsion balance at 4 p. m. daily.

After the sticks were tested over different litters, all of them were exposed over the ponderosa pine needle bed and weighed regularly to measure the variation in individual sticks. Curves were drawn showing the relation of the observed moisture content of each stick to that of the stick over ponderosa pine needles. These curves were then used to correct the observed stick moistures for stick differences.

The data for the stick over ponderosa pine needles were grouped into two broad moisture content classes. Then the average corrected moisture content was computed for the other sticks in each of these two classes. The indicated moisture content at 4 p. m. of these fuel-moisture sticks exposed over 8 kinds of litter was as follows:

	Moisture content (percent)		
Litter type:	*3.5–5.9 percent class* [1]	*6.0–8.4 percent class* [2]	*Average* [3]
Ponderosa pine needles	5.1	6.6	5.7
Oak leaves	5.1	6.2	5.6
Snowbrush leaves	4.9	6.2	5.4
Manzanita leaves	5.1	6.2	5.5
White fir needles	5.2	6.0	5.5
Bitterbrush leaves	5.3	6.1	5.6
Mixed conifer needles	4.7	6.1	5.2
Cured grass	5.0	6.0	5.4

[1] Basis: 13 days. [2] Basis: 9 days. [3] Basis: 22 days.

None of the fuel-moisture sticks exposed over the different litter types used in this study showed any significant difference in indicated moisture content. Morris[2] found that there is no difference in the moisture content of sticks exposed 9 inches and 12 inches above Douglas-fir litter, bare ground, and gravel. It is thus probable that the type of ground cover immediately under fuel-moisture sticks is relatively unimportant when the sticks are exposed 9 inches or more above the surface. Ground cover of some type of dry litter is advisable, however, to keep the sticks from being splashed with mud during heavy rain.

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[2] MORRIS, WILLIAM G., EFFECT OF GROUND SURFACE AND HEIGHT OF EXPOSURE UPON FUEL MOISTURE INDICATOR STICK VALUES. Pacific Northwest Forest Expt. Sta. Forest Research Note 30, pp. 5–6. 1940. [Processed.]

CONVERSION OF A MILITARY CARGO CARRIER INTO A TANKER TRAILER

Gilbert I. Stewart

Supervisor, Michigan Forest Fire Experiment Station

Among the many vehicles declared surplus by the armed forces is a small trailer, known officially as "Trailer, dump, 2-wheel, ½-ton, air-borne." It was designed for use as a general cargo trailer, and was matched in size, capacity, and tread with the jeep. Most of the repair parts are interchangeable with those of the jeep, especially the running gear. The vehicle is fully covered in Technical Manual TM5–9084. Many of these trailers were sold as surplus items, and fire control agencies will find in them a useful vehicle for conversion to flat-tank water carriers.

During 1947 the Michigan Forest Fire Experiment Station carried out a rather extensive research project dealing with tanker design, in conjunction with the military jeep, the Dodge power wagon, and a number of tanker trailers to accompany them as accessory water carriers. One phase of this work was concerned with the trailer described above, and from it was developed a pilot model that might be of interest to other fire control agencies.

Reference is suggested to TM5–9084, but in case a copy is not available, a brief description and the accompanying photographs might clarify this report. The trailer is manufactured as a dump trailer and the bed is a sturdy metal box manufactured as a single piece. A heavy tail gate is provided to permit use as a dump box. There are no springs on the unit. Full electrical equipment is installed for taillights.

Examination of the box suggests the removal of the tail gate and the substitution of a rear bulkhead welded all around and made watertight. With additional baffle plates, angles, and cross members, the original dump box can be converted into a splendid water tank, with valuable features of design that cannot be found usually in commercial tanks (fig. 1).

For sake of completeness in describing conversions, the following details may be left unchanged:

1. The dumping feature need not be changed, although convenience in the installation of plumbing and intake hoses might determine otherwise.
2. The pintle hook for towing may be retained, if the towing vehicles are equipped with the corresponding hook. Otherwise, some sturdy type of ball hitch is required and the standard ball in the 2-inch size is recommended.
3. Tail lighting fixtures may be retained. The plug will fit into the standard socket supplied on the military jeep. Otherwise, some suitable set of plugs and sockets may be selected as standard between all towing vehicles.
4. The leg pedestal should be left intact.
5. The lack of springs under the bed is no particular disadvantage and need not be corrected.

Possible changes are as follows:

1. If the dumping feature is discarded, remove all mechanism associated with tripping and locking. These are the tail-gate catch, dump release assembly, trip handle assembly.
2. Tail gate must be replaced with a solid steel rear bulkhead, preferably not heavier than ⅛-inch. Fitting the new piece must be accurate to conform to the size and shape of the box, and to permit a watertight weld along all sides.
3. It might be found desirable to replace the pintle eye (lunette eye) with a longer tongue to permit closer turning, or to guarantee necessary clearance if the vehicle is used behind tractors.
4. Install supporting angles for attaching baffle plates. The accompanying photographs show the box divided into six compartments. The location of the angles at top of baffles and along the floor are shown; to these angles the baffle plates are welded, leaving spaces at corners for passage of water from one compartment into the adjoining ones.
5. A flat cover plate must be attached to the top of the tank. The surface angles are tapped, and the cover plate drilled to conform. Attachment is by means of brass machine screws.
6. The rear corners of the tank are outfitted with filler ports; these are equipped with long strainers reaching to the bottom of the tank and are removable for cleaning.
7. To the bottom of the tank, proper flanges must be attached for plumbing the suction lines to pumps.

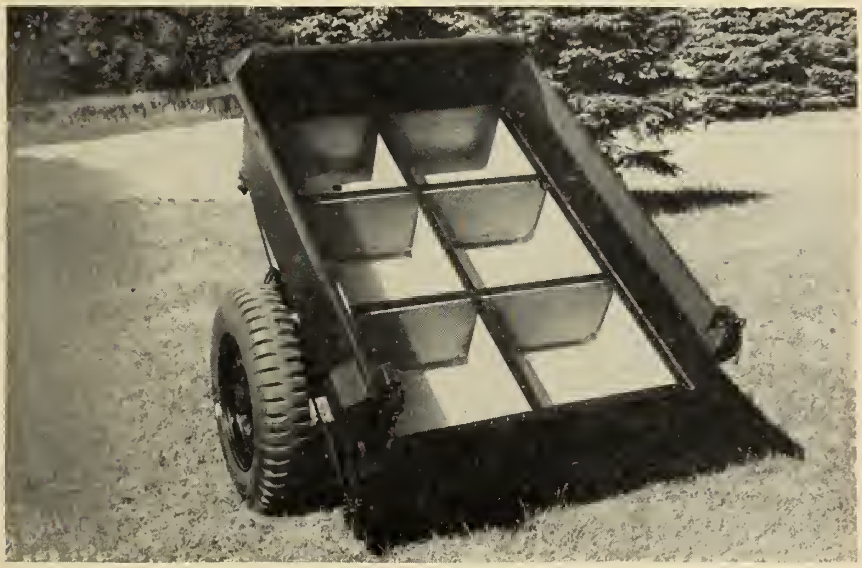

FIGURE 1.—The original trailer box is easily converted. The baffle plates contribute to improved travel characteristics, especially in the absence of springs. The tapped holes for attaching the cover plate are all located in the top surface of the angles. By removing the top plate the interior is easily accessible for repair, refinishing, or cleaning.

The removable top has proved very useful in providing access to the interior for refinishing, repair or seasonal cleaning. Figures 2 and 3 illustrate the fact that deck space is left for items which might have to be carried on top of the trailer.

The flat deck also provides a position for a power pump if desired (fig. 2). If this feature is incorporated in the outfit the unit becomes

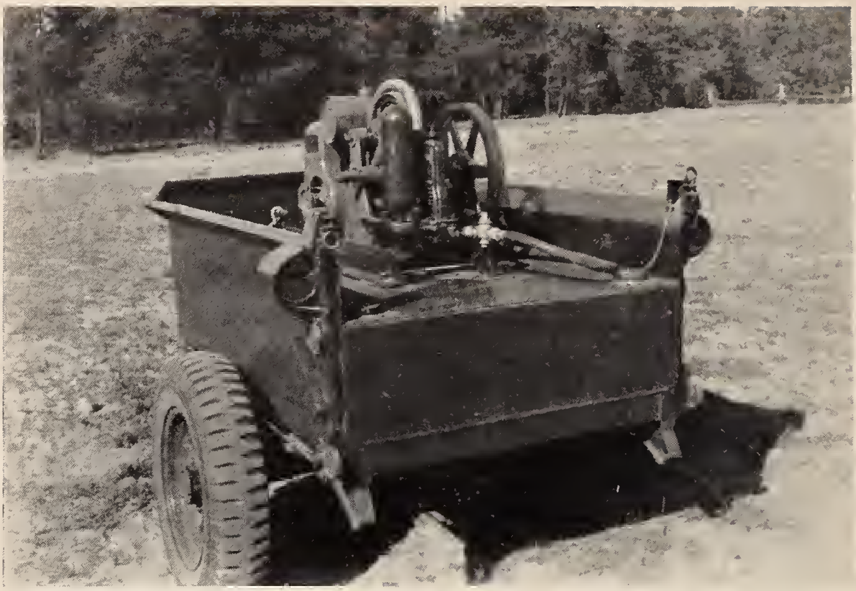

FIGURE 2.—The trailer may be mounted with a power pump on the top deck, in which case it becomes a self-contained tanker. Two filler ports equipped with strainers are provided.

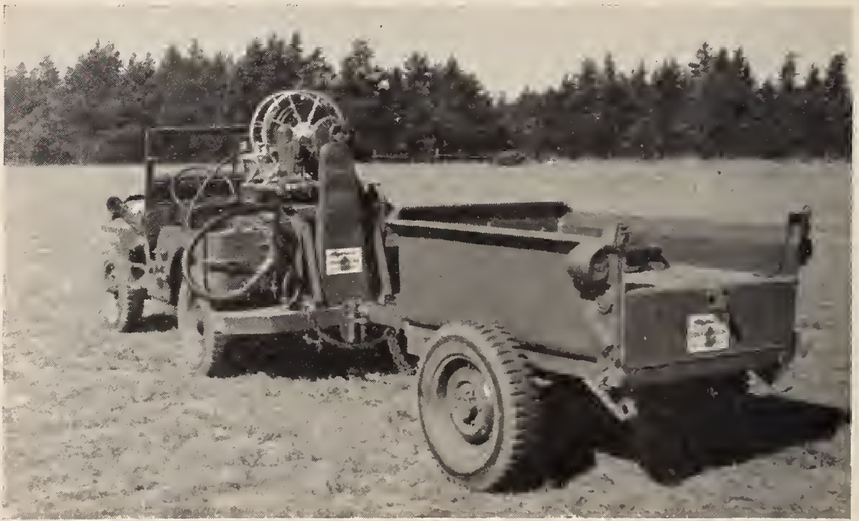

FIGURE 3.—Towed by a jeep the trailer provides 110 gallons of water in addition to that carried in the truck. If conditions of terrain become too difficult to haul the trailer in actual fire fighting, it may be dropped off at will and the water used as tank refill on the jeep truck.

a self-contained tanker, able to work behind any towing vehicle including tractors. The pump illustrated is a Bean Little Giant No. 66, capable of 400 pounds pressure and 7 gallons per minute. Used with a modern spray gun the water is employed most effectively, since the high pressure of the stream produces a strong sweeping action in burning fuel.

If the outfit is used as a water carrier only, a wide variety of combinations is possible. One of these is illustrated with the trailer transported by a jeep (fig. 3). In this case the pump becomes part of the truck and is driven by a power take-off. The jeep is also equipped with a built-in tank of 60 gallons. If the trailer becomes awkward to transport behind a towing vehicle, it may be dropped and its water content employed as tank refills for the truck. This becomes the case in about 50 percent of the fire runs.

It will be found desirable to equip either the trailer or truck unit with a live reel and the usual tool equipment necessary to operate power pumps. One experimental assembly is illustrated: in this instance the entire reel is mounted on a cabinet containing a tool drawer (fig. 4). The entire assembly constitutes a complete unit which may be handled or mounted as one piece, either on the trailer or truck.

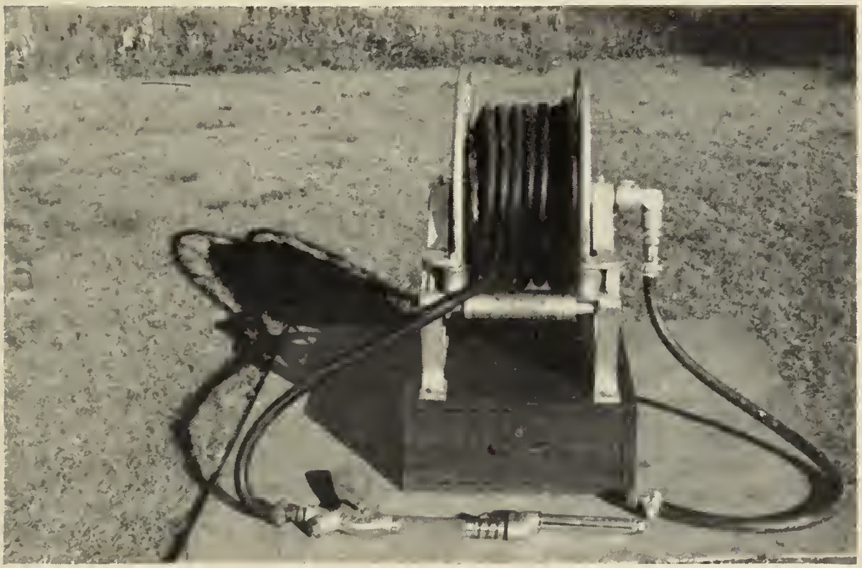

FIGURE 4.—A live reel and tool box unit developed to accompany trailers or tankers of this kind. It may be mounted as a complete assembly, either on the trailer or the truck. The tool equipment includes a complete issue of wrenches, pliers, screw driver, gaskets, hose fittings, and a variety of items required to operate and maintain power pumps.

In trailer tankers of this kind, total water capacity must be decided by the design. Capacity also depends on proposed use and assignment. In the trailer illustrated, it is limited to 110 gallons, although the original box is large enough to provide for a tank of 175 gallons without difficulty and still leave enclosed deck space for other cargo.

Total gross weight with water cargo will approximate 1,500 pounds which permits road use in Michigan without brakes.

Specifications of the original trailer are as follows:

Weight	636 pounds	Length	93½ inches
Height	45½ inches	Width	56 inches

To date, the best use of this outfit, transported by a jeep, is in fast initial attack. The use of high water pressure has been found effective and efficient in the application of small quantities of water. It has also been found that even though the trailer might not be transported behind a truck while fire is being fought, the prompt refill of tanks from the trailer tank insures immediate return of the truck to fire fighting.

In all tanker equipment the problem of refilling at water sources must be solved. In this case an ejector type of tank filler is used. It is operated by the Bean pump at a pressure of 400 pounds. Suction lift is most efficient at 15 feet or less and capacities are as follows:

Suction lift:	*Gallons per minute*
15-foot	20
10-foot	24
5-foot	28

These refill capacities are secured with an input of 6 gallons per minute at 400 pounds pressure.

Three Projects in Process at Arcadia.—The following are three of the projects in process at the Arcadia Fire Control Equipment Development Center.

Ejectors . . . Known also as eductors, injectors, tank fillers, and jet pumps. For use as quick tank fillers they indicate a possibility of filling tanks at from two to three times regular pump capacity. They can also be used for drafting from ponds with tanker up to 200 feet from water source or for drafting on lifts up to 100 feet. Eventual development may eliminate suction hose and reduce danger of pump damage when pumping dirty water.

Small hose . . . With the field trend definitely toward smaller nozzle tips and reduce flow, the use of 1-inch and 1½-inch hose for single streams becomes less necessary. Present study is in friction loss and other properties of hoses from ⅜ inch to 1 inch in linen, high-pressure, and cotton-jacketed rubber-lined. Advantages of small hose are higher allowable operating pressures, lighter weight, less storage space, longer length can be handled by a single man and hose can be had in single continuous lengths.

Back pack . . . A back-pack pump outfit of 4-gallon capacity and having a pump with 8 less parts than present units is being investigated. Advantages noted from preliminary tests include light weight, improved pump, a cost 25 percent less than present commercial models, convenient right- or left-handed use of pump without removing unit from back.—Arcadia Fire Control Equipment Development Center, *Region 5, U. S. Forest Service.*

55-GALLON SLIP-ON PUMPER-TANKER

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

The Arcadia Fire Control Equipment Development Center was assigned a project to construct a light slip-on tanker suitable for jeep and pickup installation, for use principally by patrolmen.

The use of small surplus spray rigs (reported in April and July 1948 issue of FIRE CONTROL NOTES), when other equipment was not available, indicated such a unit to be desirable. The basic specifications indicated that it be a complete self-contained unit, as light as possible, high water-weight ratio, and be equipped with a pumper unit with an output of at least 18 gallons per minute at 250 pounds per square inch.

A slip-on tanker meeting these specifications was designed and constructed, using a pumper unit which has met requirements for a light, portable outfit under specification "Portable Pumpers, U. S. F. S. R–5, Model 47, revised October, 1947."

The unit, consisting of a pump and engine and one large box mounted on a water tank (fig. 1), weighs 373 pounds without equipment, and with tank empty. Fully equipped for pumping on a fire, it weighs 950 pounds.

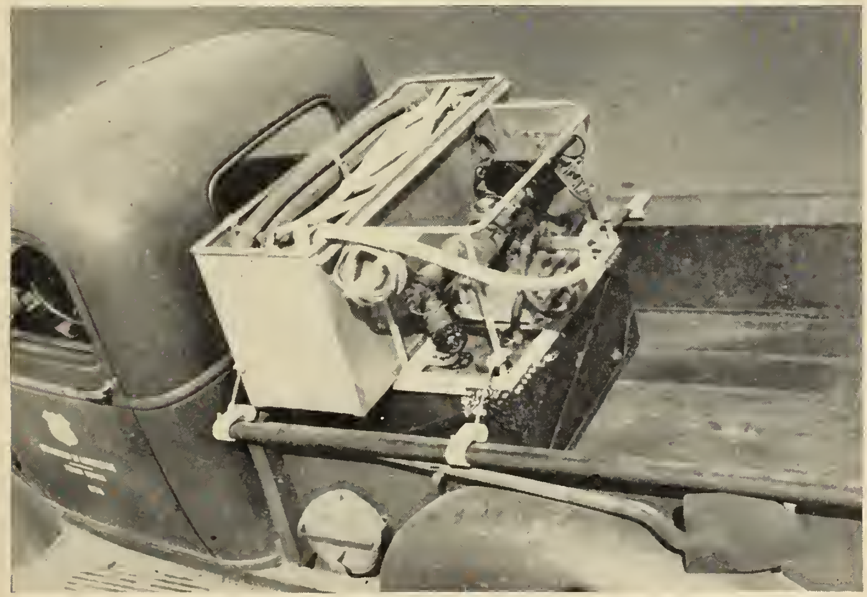

FIGURE 1.—55-gallon slip-on unit mounted in pickup.

The small positive displacement pump is powered by an air-cooled gasoline engine which is rated at 6 horsepower and 2,700 revolutions per minute. The pump and engine make a unit 24 inches long, 16¼ inches wide, and 20 inches high, weighing 96 pounds. The unit is equipped with a rope starter. Following is a table showing pump performance in gallons per minute at various discharge pressures and with 3 feet of water suction lift:

Pressure (pounds per square inch)	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	25
100	22½
250	18
310	16

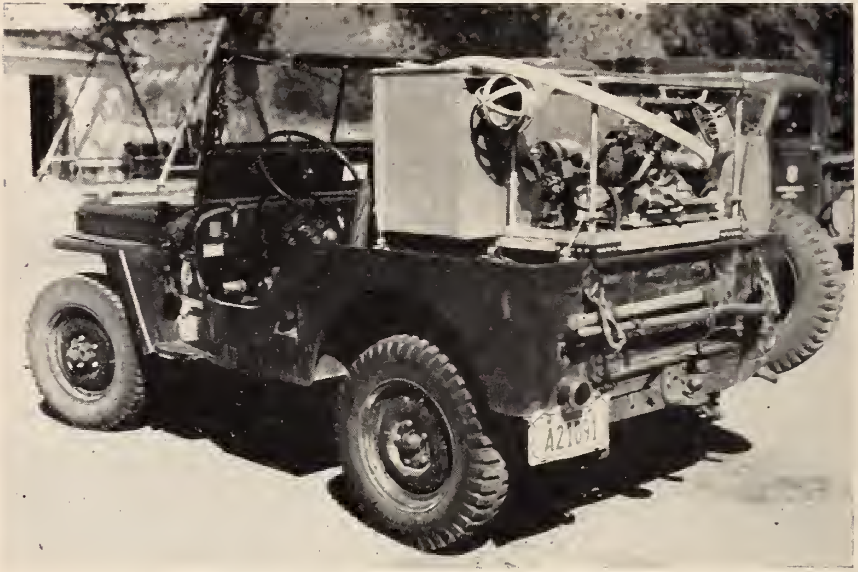

FIGURE 2.—Slip-on unit mounted in jeep.

The 55-gallon water tank is made of 14-gage aluminum alloy. It is 28½ inches wide, 32 inches long, and 14½ inches high. An aluminum box provides space for the 5-gallon gasoline tank, a tool kit, four 4-foot lengths of 1½-inch suction hose, and 200 feet of 1-inch cotton-jacketed, rubber-lined hose. Four clamps and turnbuckles provide a means for rapidly securing the unit to a jeep, weasel, or pickup bed (fig. 2).

The pumper is equipped with four folding handles for use in carrying as a portable pumper. It is mounted on two angle irons at the base, to which the pipe frame is attached. By removing four bolts and disconnecting suction and bypass lines, the pumper can be removed for portable use.

Observations and conclusions.—Based on field use for one season, a combination jeep and pickup unit is not recommended as practical. Because of the dual purpose, design compromises reduce efficiency for the pickup installation. It appears more practical to design separately for the jeep and for the pickup.

Aluminum construction used in both pumps and tank has given trouble due to electrolytic action between aluminum and chemicals in water available in certain areas. Baffles have pulled loose at spot-welds, causing holes in tank. Hard starting and difficulty with pumps freezing can also be attributed to this cause.

When installed in a jeep bed, the aluminum tool and hose box gives the appearance of top-heavy design. Basically, the center of gravity of the loaded vehicle is sufficiently low to insure safe operation. The psychological effect on field men, however, is adverse.

The concensus of field men in several regions indicates that hose baskets, as such, are not satisfactory for general tanker use. A hose reel, preferably live, is more desirable.

Further work is scheduled for this fiscal year on the the design of a unit for the ½-ton pickup only. Additional work on a jeep installation is being carried on by Region 9. For details of the unit described, refer to Specification "Slip-on Pumper-Tanker, U. S. F. S. R–5, Model 48," and Drawing F–2–03 on file at the Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

Use of Firefinder to Measure Fires.—William T. Stephenson, lookout man on Ranger Peak, San Bernardino National Forest, uses his firefinder and a table to determine the diameter of fires.

Table 1 gives for each minute reading on the azimuth circle the diameter in feet of a fire 1 mile away. The table also gives diameters for each degree reading on the azimuth circle.

Example: To determine the diameter of a fire 8 miles away. A sight on one side of fire reads 31°20′. The sight on opposite side of fire is 32°33′. The difference between the two readings is 1°13′; this is the width of fire in degrees and minutes. From the table, 1° gives 92.40 feet, and 13′, 20.02 feet, a total of 112.42 feet, the diameter at 1 mile. The diameter of the fire 8 miles away is 8 times 112.42 or 899.36 feet.

TABLE 1.—*Predetermined diameters of fires 1 mile away by minutes and degrees of angle*

Minutes	Feet	Minutes	Feet	Minutes	Feet	Minutes	Feet	Degrees	Feet
1	1. 54	16	24. 64	31	47. 74	46	70. 84	1	92. 40
2	3. 08	17	26. 18	32	49. 28	47	72. 38	2	184. 80
3	4. 62	18	27. 72	33	50. 80	48	73. 92	3	277. 20
4	6. 16	19	29. 26	34	52. 36	49	75. 46	4	369. 60
5	7. 70	20	30. 80	35	53. 90	50	76. 90	5	462. 00
6	9. 24	21	32. 34	36	55. 44	51	78. 44	6	544. 40
7	10. 78	22	33. 88	37	56. 98	52	79. 98	7	646. 80
8	12. 32	23	35. 42	38	58. 52	53	81. 52	8	739. 20
9	13. 86	24	36. 96	39	60. 06	54	83. 06	9	831. 60
10	15. 40	25	38. 50	40	61. 60	55	84. 60	10	924. 00
11	16. 94	26	40. 04	41	63. 14	56	86. 14		
12	18. 48	27	41. 58	42	64. 68	57	87. 68		
13	20. 02	28	43. 12	43	66. 22	58	89. 22		
14	21. 56	29	44. 66	44	67. 76	59	90. 76		
15	23. 10	30	46. 20	45	69. 30	60	92. 40		

THE TABER BRUSH CUTTER

W. S. Taber

State Forester, Delaware Forestry Department

Two brush cutters suitable for Coastal Plain terrain or similar soil and vegetative conditions have been constructed, specifically for the Clarkaire tractor, by the Delaware Forestry Department. One of the brush cutters is permanently attached to the pusher arms or A-frame (fig. 1), the second is bolted on at three points (fig. 2).

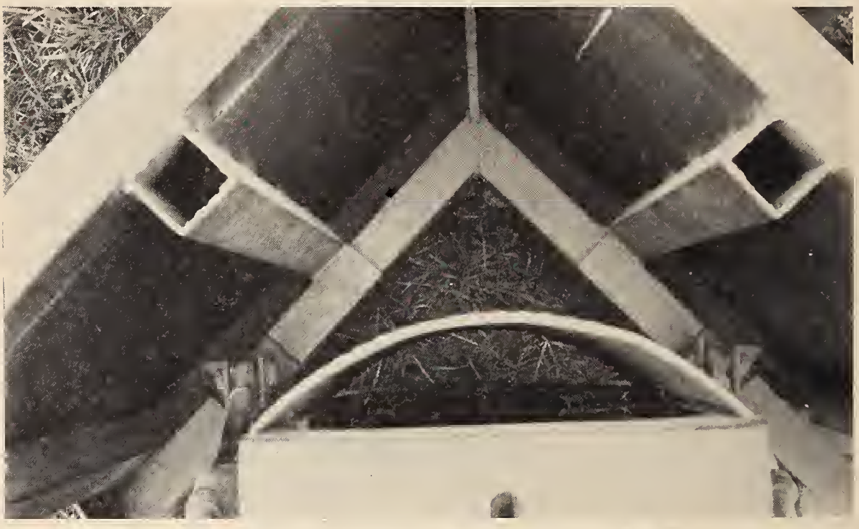

FIGURE 1.—Taber brush cutter permanently attached to A-frame. (Photographs by Delaware State Forestry Department.)

The Clarkaire tractor has sufficient power to cut off live trees up to the protruding width of the blade which in our case is 3½ inches. By making a pass on either side of a larger tree, trees up to 7 inches butt diameter may be severed.

The brush cutter uses hard steel-backed paper knives ⅞ inch thick and 5½ inches wide. The knives are welded to a framework of 3- by 3- by $\frac{3}{16}$-inch cold-drawn seamless tubing and 16-gage sheet iron. This framework is welded to the A-frame or provision is made for bolting. The vertical nose is also made from a paper knife and serves to cut briers (fig. 3). Angle irons, 3 by 3 by ¼ inches, are welded to the posts, knives, and sheet iron for further strengthening. A 3-inch skid shoe at the point of the bottom knife keeps it from digging. Cost of construction per brush cutter is $20 for paper knives, $35 for square tubing for posts and top rail, $15 for 16-gage sheet iron and other odds and ends, and $70 for welding.

The radiator guard illustrated in figure 1 is made by splitting a perforated hammer mill screen in half, welding the halves in the center, and skip-welding the guard to the outer radiator shell. Screen material is $\frac{3}{16}$ or ¼-inch thick and is reinforced with ½-inch iron round rods at top and bottom. Cost is $10.

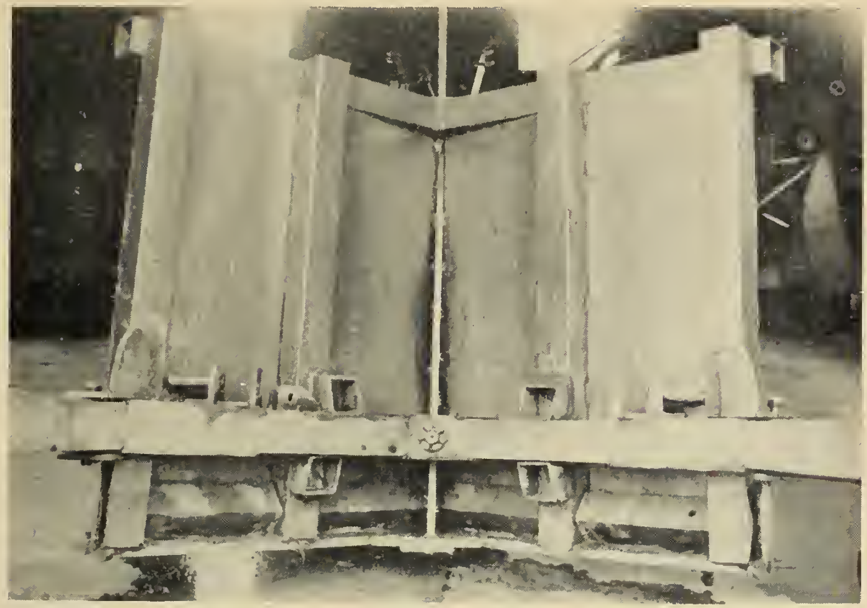

FIGURE 2.—Slip-on brush cutter with A-frame in place; bolt in center is a 1-inch clevis bolt which straddles vertical knife.

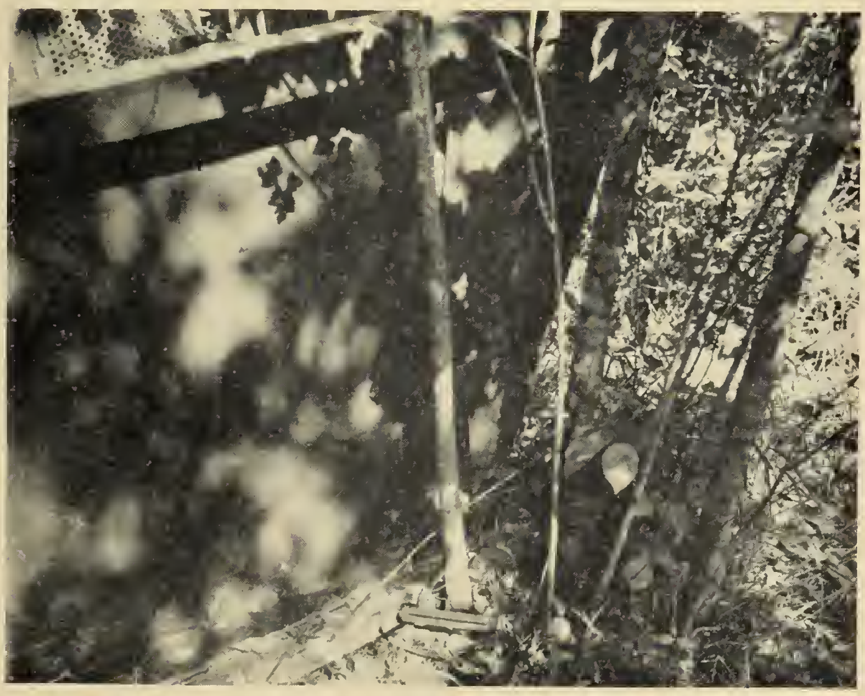

FIGURE 3.—Taber brush cutter depends on sliding action of knives. Note slant of vertical knife.

250-GALLON SLIP-ON PUMPER-TANKER

Arcadia Fire Control Equipment Development Center

Region 5, U. S. Forest Service

Recent trends in the Forest Service have been toward the use of slip-on and demountable tankers to replace conventional fire trucks. In general, fire trucks, whether in use by the Forest Service, State, county, or city fire departments, become obsolete even though actual vehicle mileage is low. The solution of this problem, particularly for those areas not having a year-round fire season, appears to be slip-on pumper-tankers. These can be readily transferred to any truck and, as a result, maximum utilization of vehicles is obtained. A slip-on unit of this type, built in 1948 for stakeside trucks in the 13,500 gross-vehicular-weight class, is shown in figure 1. The improved unit shown in figure 2 was built in the spring of 1949.

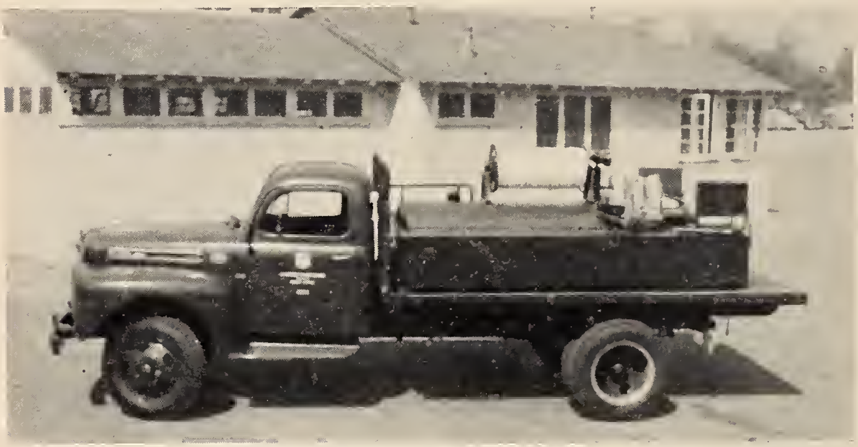

Figure 1.—Pumper-tanker unit built in 1948.

The 1949 unit consists of a tank; pumper; live hose reel; tool, hose, radio, and equipment boxes; and hose basket mounted on a skid frame. The unit can be made self-contained, having as extras its own batteries, lighting system, siren, spotlight, and red light. It is fastened to the chassis frame of the vehicle with four **J**-bolts. Seating accommodations for two crew men are provided.

The over-all dimensions of the unit are 10 feet 11 inches long, 6 feet 7 inches wide, 2 feet 5 inches high, to top of fill spout. The empty weight, without water, hose or fire tools, is 2,095 pounds. Filled, equipped with all fire-fighting equipment listed further in this article, and including two crew men in the seats, the unit weighs 5,290 pounds.

The pumper unit used has a rated capacity of 30 gallons per minute at 250 pounds per square inch, 45 gallons per minute at free discharge, and 23 gallons per minute at a maximum pressure of 340 pounds per square inch. It is a positive displacement gear type, driven by a 10-

horsepower, opposed twin cylinder, air-cooled, four-stroke cycle engine. The unit is electrically started, being equipped with a 12-volt starter generator system. Provision is made for emergency rope start. The pumper unit is also available with rope start only. The space allotted for the pumper is sufficient to allow for the installation of other types of pumpers, such as higher or lower pressure gear, piston, or centrifugal type units in the comparative weight class. The pumper unit used weighs 192 pounds.

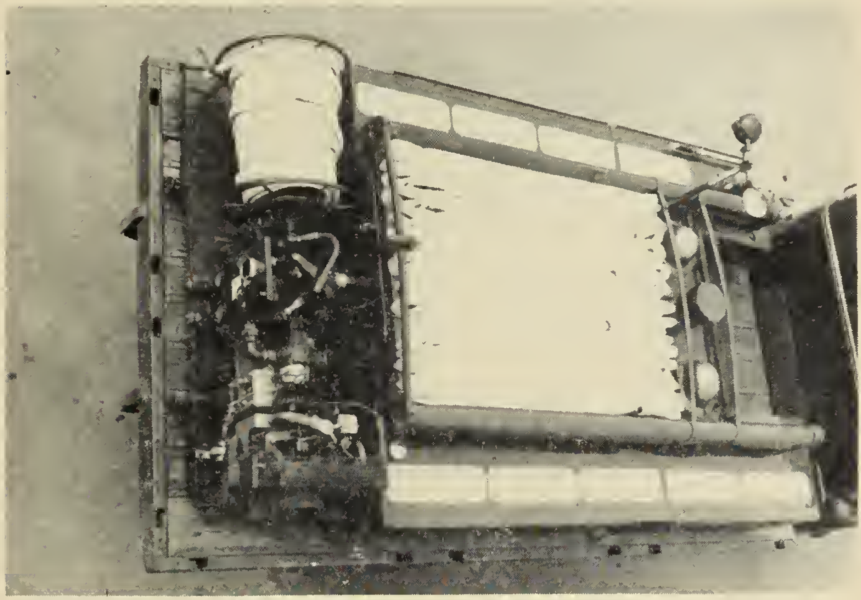

Figure 2.—Pumper-tanker unit built in 1949.

The 250-gallon tank, constructed of 14-gage black iron, is divided into three compartments by two transverse baffles. For ease in fabrication, cleaning, and painting, the entire top cover is removable. The tank is 6 feet long, 3 feet wide, and 22 inches high. The hinge-capped fill spout has a 16-mesh strainer. Other tank openings are 1½-inch for suction and fill, and 1-inch for drain, vent, and relief valve return. After fabrication and testing, the interior of the tank is sandblasted and given three coats of a sanitary rust preventive paint. Gage cocks, with plastic tubing, are provided at the rear end of the tank to show the water level.

All operating valves and piping are mounted as a single assembly adjacent to the pump. Valve handles, pressure regulator and pressure gage are mounted on a panel board. Suction connection from pump and tank to pipe assembly is by means of 1½-inch hose. A 16-mesh strainer is provided in the overboard draft line. A combination panel and red light is mounted on top of panel.

The high-pressure hose reel will accommodate 250 feet of 1-inch cotton-jacketed rubber-lined or ¾-inch high-pressure hose. Hose reel is constructed to withstand an operating pressure of 800 pounds per square inch. The reel is equipped with an eccentric type quick-throw friction drag brake, and a geared crank for winding in the hose. Figure 3 is a closeup of the rear, showing pumper, control panel, and reel.

There are four equipment boxes, two mounted on each side of the tank. They are mounted on T-iron outriggers fastened to the main frame. If desired, either or both of the forward boxes could be replaced with hose reels. On the right side (fig. 4) the forward box has been left empty for use in carying crew's duffel, additional hose, or equipment. The rear box is used to carry fire tools, flashlights, fuses, etc. The fuel tank for the pumper is installed in this box.

On the left side (fig. 5) the forward box is used to house the storage batteries and for the installation of radio equipment. The rear box is used to store nozzles, strainers, adapters, and additional hose.

At the forward end of the unit, between the boxes, two crew seats are installed. In this position the men are fully protected by the vehicle cab in front and the boxes on the side. In most vehicles a small amount of forward vision is available through the rear window of the cab. As shown in figure 6, the seats are low and, in this position, it is unnecesary to provide safety straps for the crew. Space is available between the back of the seats and the front of the tank to accommodate four 1-gallon canteens. Design revision scheduled for this fiscal year will provide alternate design to accommodate three men.

Four 8-foot tubes, two to the side, are mounted on the tops of the equipment boxes. These are for storage of the suction hose. The 1½-inch suction hose is easily removed from the forward end of the unit. These tubes also form the sides of the hose basket on the top of the tank.

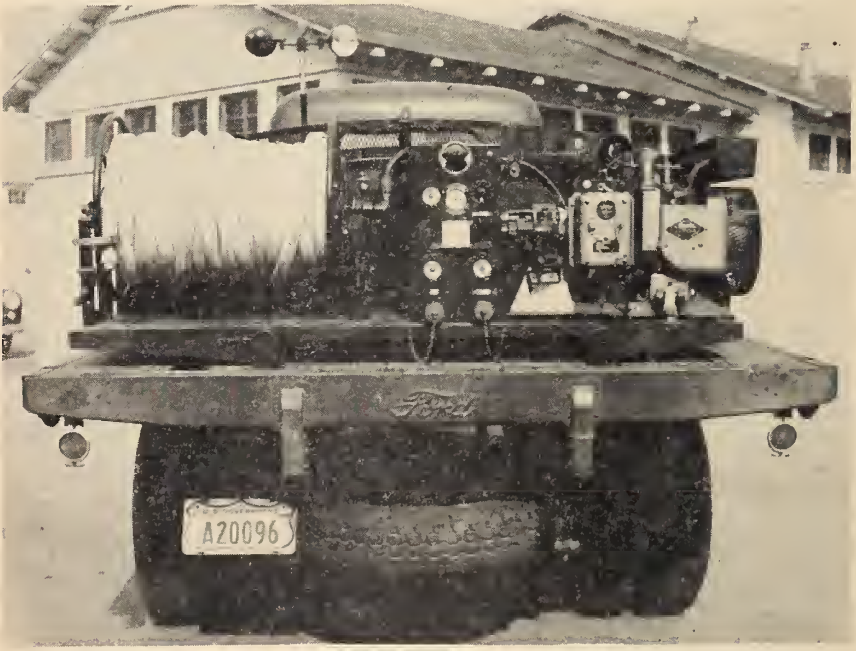

Figure 3.—Slip-on unit showing live reel, control panel, and pumper.

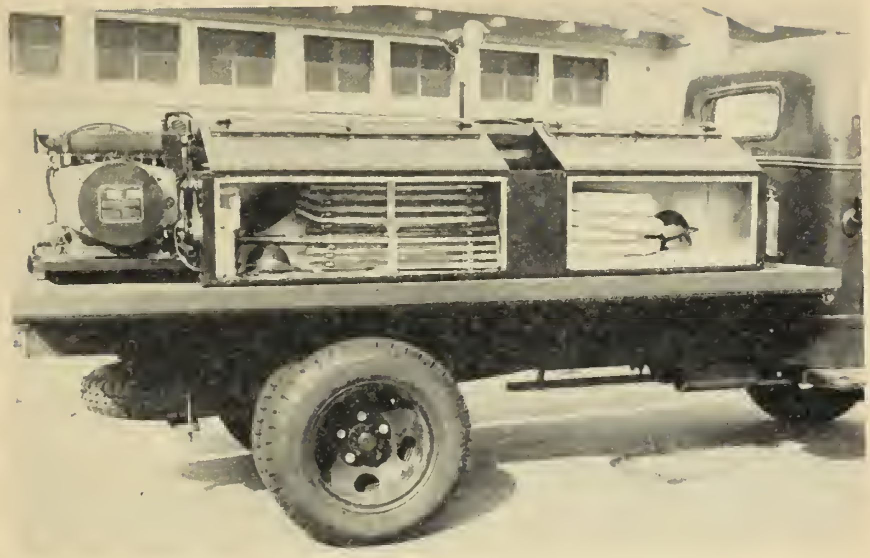

FIGURE 4.—Equipment boxes on right side of unit.

The top hose basket (fig. 2) accommodates 250 feet of 1½-inch cotton-jacketed, rubber-lined (CJRL) hose, laid in accordion fashion. Expanded metal on angle-iron frames is used to form the ends of the basket. Oak slats are installed over the tank to serve as the basket bottom and to allow for air circulation under the hose.

For maximum safety, adequate guards have been installed over engine flywheel and the muffler. Nonskid surfacing has been applied to the tops of the equipment boxes. Grab handle has been installed on top of box to facilitate boarding and leaving vehicle. A red spotlight and a white spotlight have been mounted on an extension pole at the front of the tank. These lights swing through 360° independently and can be used for warning, as well as locating items in the vicinity of the vehicle. By means of the extension pole, the lights can be raised sufficiently to shine forward over the cab of the vehicle. The siren is operated by means of remote cable and push button controls mounted in the truck cab.

To facilitate engine maintenance and operation, brass plates containing necessary instructions are mounted on pumper and valve panel. Valves are further identified by numbering, to tie them in to the operating instructions. All parts of the unit used in normal operation that cannot be reached from the ground are accessible from the space in front of the crew seats.

This unit is intended for use as a primary first attack tanker operated by a crew of four men. It carries sufficient hand tools to outfit a crew of at least eight men.

In April 1949 bids were let by Region 5 for construction of 12 of these units. The low bids were approximately $1,350 for the unit, less pumper, and $575 for the pumper unit. Hose, fire tools, backpack pump, and other equipment cost approximately $750.

The list of equipment furnished for the unit is as follows:

1 Set of tools for engine and pump.
1 Back-pack pump, complete.
4 Lengths of suction hose, 1½-inch (8-foot lengths).
1 Strainer for suction hose.
1 First aid kit.
4 Hats, protective.
1 Siamese valve, 1½-inch.
11 Lengths hose, CJRL, 1-inch (50-foot lengths).
10 Lengths hose, CJRL, 1½-inch (50-foot lengths).
3 Shovels, size 0.
2 Axes, double-bitted.
2 Brush hooks.
1 Fire extinguisher, 1½-quart.
1 Wrecking bar.
1 Bolt cutter.
2 Garden hose nozzles.
4 Spanner wrenches.
2 McLeod tools.
2 Pulaskis.
4 1-gallon canteens.
1 Automatic check and bleeder valve.
2 Nozzles, shutoff, twin tip, with fog and solid stream tips.
3 1½-inch to 1-inch adapters.

This unit (fig. 2), being the second model of this class, shows considerable improvement over the original unit (fig. 1). With the experience gained in two seasons' use of this equipment, we are preparing final plans and specifications which will be but slightly improved over this 1949 model. Alternate pumper and piping layouts are being prepared. A new live hose reel is being planned, to facilitate paying out of the hose to the sides of the vehicle. Crew seats are being redesigned to accommodate three men. We are also working on the design of a larger tank for use in those areas where mountain

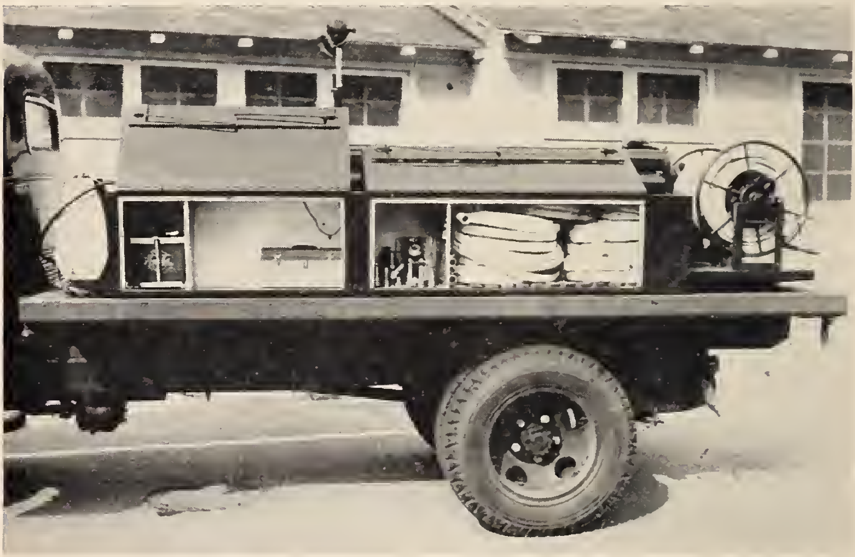

Figure 5.—Equipment boxes on left side of unit.

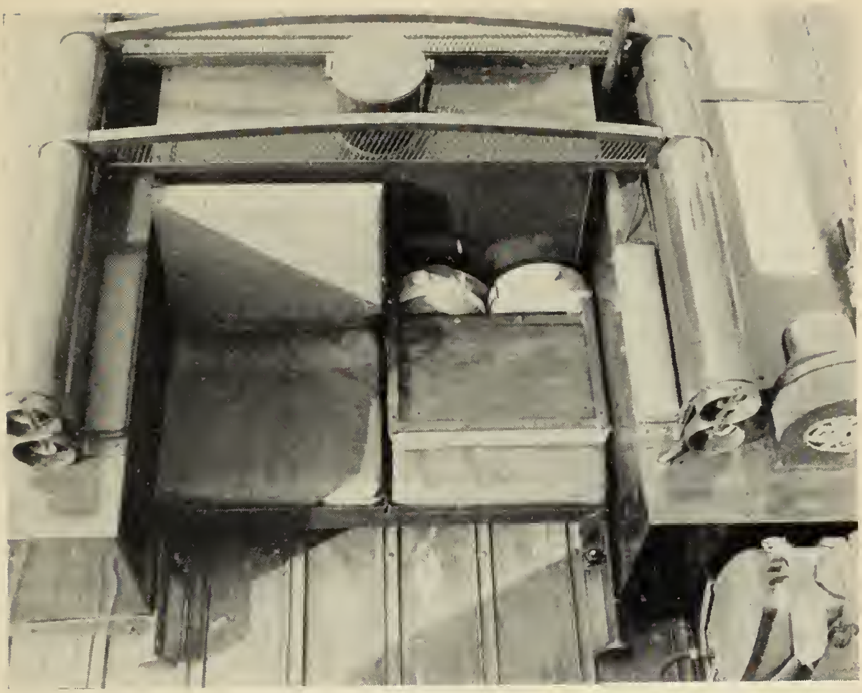

FIGURE 6.—Front end of unit showing seats for two men, space behind seats for canteens, and the four 8-foot tubes for storing suction hose.

grades and off-road terrain are not as severe as they are in the western regions, and loading to the maximum gross vehicle rating can be made without sacrificing speed and maneuverability.

The construction of this 250-gallon slip-on pumper-tanker is covered under Arcadia Fire Control Equipment Development Center Drawings Nos. F–17–01, F–17–02, F–17–03, F–17–04, F–17–05, and F–1–10; and Specifications "1½-ton Slip-on Tanker, U. S. F. S. R–5, Model 49," and "Live Hose Reel, U. S. F. S. R–5, Model 48, revised March 4, 1949, Size 3." The pumper unit is covered by Specification "Portable Pumper, U. S. F. S. R–5, Model 49 (30 gpm at 250 psi, 4-stroke cycle gasoline engine, battery ignition, electric start)." Plans and specifications are available at the Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

MECHANIZED FIRE FIGHTING ON A GULF COAST RANGER DISTRICT

Russell E. Rea

Assistant Chief of Fire Control, Region 8, U. S. Forest Service

The advantages from applying mechanized fire equipment to the fire suppression job are becoming more and more evident. It has reached a high stage of development in the coastal flatwoods belt stretching from North Carolina to Florida and around the Gulf Coast to Texas. Some of the results can best be shown by analysis of its use on a typical coastal ranger district. Developments on the Biloxi Ranger District of the Mississippi National Forests offer a measurable example.

One hundred fires occurred on this District during the period January 1 through September 15, 1949. Total acreage burned was 1,019 acres, an average of about 10 acres per fire. Total length of line constructed to control the 100 fires was 4,357 chains; 3,826 chains, or about 88 percent of this line, were constructed with mechanized equipment.

The Biloxi Ranger District has a protection area of about 200,000 acres. It is predominantly flatwoods type with longleaf-slash pine and a fast burning ground cover of grass and underbrush. Fire occurrence and area burned during the period January 1 through September 15 are as follows for 1945–49:

Year:	*Fires (number)*	*Total acreage burned (acres)*	*Average size of fires (acres)*
1945	90	4, 800	53
1946	288	6, 107	21
1947	295	6, 594	22
1948	158	3, 747	24
1949	100	1, 019	10

Decreasing acreage subsequent to 1947 directly reflects the development of mechanized equipment. This ranger district has six Ranger Pal plows, one Mathis plow, and one Dodge power wagon tanker. Ranger Pal plows are transported on 1½-ton stake trucks. The Mathis plow is transported by semitrailer.

Both the Ranger Pal and Mathis tractor-plow outfits are described in detail in the U. S. Forest Service Fire Control Equipment Handbook. The Dodge power wagon is equipped with a 180-gallon water tank and package unit power pump. All transport equipment is equipped with 2-way mobile FM radio.

Mechanized equipment has largely displaced manpower on this ranger district. Individual fire records for the 100 fires in 1949 show that the maximum number of men used on any one fire was 15. Thirty-eight fires were handled with only 3-man crews and the average number of men per fire was 5. Ninety-eight of the 100 fires were of incendiary origin, varying in the number of sets from 1 to 18. The average number of sets per fire was 3. Forty-one fires were recorded as having only one set.

Tractor-plow outfits are strategically distributed over the protection area to facilitate quick attack. Small fires are handled with one outfit; large fires or ones with multiple sets are handled with two or more outfits. Actual use of equipment on the 100 fires is as follows:

Equipment used:	*Number of fires*
1 plow	53
2 plows	26
3 plows	3
4 plows	1
1 power wagon tanker	3
1 plow and tanker	5
2 plows and tanker	3
Hand tools only	6
	100

Occurrence of fires by fire danger classes is shown below. The longleaf-slash pine danger meter, used on this area, rates fire danger in five classes: Class 1 is practically no fire danger, Class 2 low, Class 3 moderate, Class 4 high, and Class 5 extreme.

Class fire day:	*Fire occurrence*
1	0
2	8
3	43
4	37
5	12
	100

The 6 fires suppressed by hand tools were handled when conditions did not necessitate mechanized equipment. Total area burned by these 6 fires was 4 acres. Ninety-one fires were suppressed at less than 25 acres each. Of the 9 fires exceeding 25 acres in area, only one exceeded 100 acres in size, having a total area of 126 acres.

These figures tell their own story of reducing the average size of fire from 53 acres to 10 acres in a 5-year period. It should also be added that mechanized equipment is only as effective as the skill of the operators and crews who use it. Experienced and well-trained crews and an alert and well-trained fire dispatcher are necessary in order to handle equipment in the manner required to produce this excellent fire suppression record.

PNEUMATIC BACK-PACK FLAME THROWER

Arcadia Fire Control Equipment Development Center

Region 5, U. S. Forest Service

A pneumatic back-pack flame thrower, using Diesel oil, has recently been designed and submitted for tests to the Arcadia Fire Control Equipment Development Center. It is a result of service requirements suggested to manufacturers for the construction of a flame thrower using straight Diesel oil, that would operate satisfactorily at pressures between 40 to 100 pounds per square inch.

In the past, the difficulty encountered with Diesel flame throwers has been in hand pumping the tank to high working pressure and in maintaining pressures required to produce the desired flame. Previous units would not operate satisfactorily at pressures under 70 pounds per square inch when using straight Diesel oil. In order to overcome the need for high pressures a mixed fuel containing part Diesel oil and part kerosene was used. This allowed for operation at from 40 to 60 pounds per square inch. However, the length of flame projection with the mixed fuel was approximately 50 percent of that obtained with straight Diesel oil. Variations in the mixture of oil and kerosene and the possibility of a dangerous oil gasoline mixture made the units undesirable. The further requirement of a separate fuel and containers further complicated the use of this type of equipment. Also the firing gun became too hot when in continuous operation and its use was restricted to intermittent firing only.

The new back-pack flame thrower consists of a tank, air pump, firing gun, shoulder straps, hose and hose connections, filler cap and pressure gage (fig. 1).

The unit fits into a space 10 inches square and 25 inches high. It weighs 18¼ pounds empty and 47¼ pounds with the 4-gallon tank full of Diesel oil.

The tank, which is 9 inches in diameter and 24 inches high, is made of 61 ST aluminum alloy sheet welded to sand cast aluminum head and base, and is tested to 250 pounds per square inch. The top head of the tank is constructed so as to prevent complete filling of the tank with oil, thus maintaining a safe minimum air chamber.

The firing gun which is 24¼ inches long, consists of an aluminum alloy tube having a pistol grip type of handle with a trigger-operated nozzle valve on one end an a flame igniter cap with asbestos wicking secured in the base on the other.

The hose connecting the firing gun to the fuel tank is provided with a coupling of the quick-disconnect instant shut-off type.

To provide a rapid and easy means of pumping up the fuel tank, a pneumatic tire type pump, with a 20½-inch stroke and 1⅜-inch diameter, is attached on the outside of tank by means of metal bands.

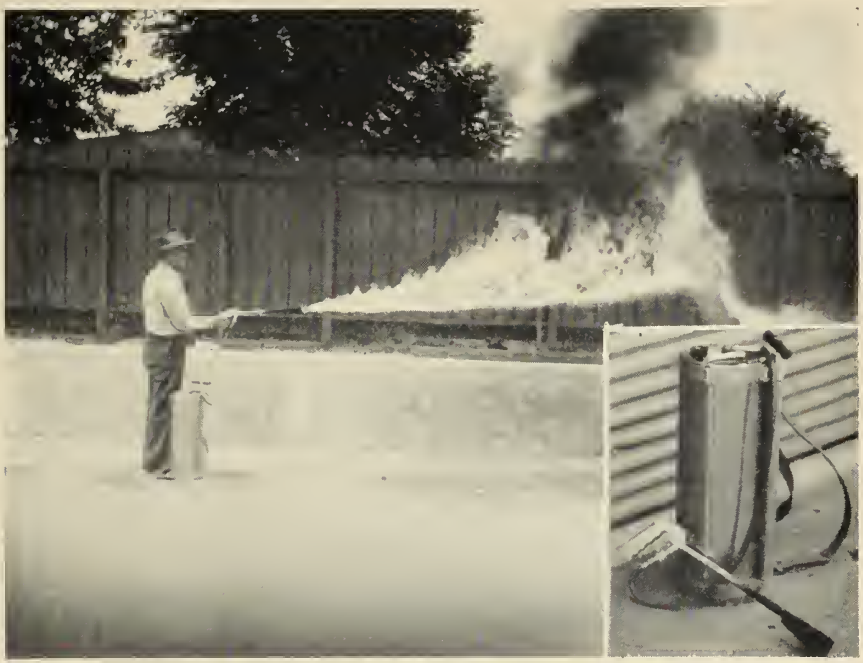

FIGURE 1.—Pneumatic back-pack flame thrower.

D-rings to which back-pack straps can be attached, are welded onto these bands.

Tests were conducted to determine: (1) Length of time and the effort required in pumping the tank up to working pressures; (2) rate of pressure drop when operating; (3) rate of fuel consumption; (4) amount of unburned fuel deposited on the forest fuel to sustain fire; and (5) length of flame projection at various pressures.

Test results were as follows:

(1) After the tank had been filled with Diesel oil to the prescribed level (4 gallons), 57 strokes of the pump were required to produce 50 pounds per square inch pressure. One hundred pounds per square inch pressure was obtained by 122 strokes in 1 minute and 50 seconds, without undue effort.

(2) After a pressure of 100 pounds per square inch was obtained in the tank, the flame thrower was operated for 4 minutes before the pressure decreased to 40 pounds. At this point 2 gallons of oil had been discharged.

(3) Fuel was consumed at the rate of 0.6 gallon per minute at pressures of 80 to 100 pounds per square inch, 0.53 gallon at 60 to 80 pounds, and 0.45 gallon at 40 to 60 pounds.

(4) One advantage of a Diesel flame thrower is that all the fuel oil is not consumed in flight and sufficient is deposited on the surface to maintain the flame. At 100 pounds per square inch pressure, practically all of the Diesel oil is consumed in flight if flame is allowed to travel its maximum distance. If directed on objects 12 to 14 feet distant, however, some Diesel oil is deposited, which, coupled with a hot

flame, produces good ignition. At 80 pounds per square inch a noticeable amount is deposited, and at 40 pounds sufficient oil remains on the forest cover to maintain the flame even under adverse burning conditions. Flame can be maintained by the torch down to a pressure of 20 pounds per square inch.

(5) Length of flame projection for various pressures is as follows:

Pressure (pounds per square inch)	*Approximate distance (feet)*
100	12–20
80	10–14
60	8–10
50	6–8
40	6–8
20	2–4

The following conclusions were made:

This flame thrower can be used for continuous firing, completely discharging a tank of fuel, without the firing gun becoming excessively hot.

An adequate air pump provides a rapid and easy means of supplying sufficient working pressures.

Diesel oil alone can be used to project a flame 6 to 20 feet at pressures from 40 to 100 pounds per square inch, respectively.

The 4-gallon tank of Diesel fuel will provide constant firing for 6 or 7 minutes at 80 to 100 pounds pressure or for 9 to 10 minutes at 40 to 60 pounds pressure.

When burning conditions are such that a deposit of oil to aid burning is not required this torch can be used as a drip or orchard torch. Under this condition only enough oil is discharged to maintain flame on the asbestos igniter pad of the flame tip. This requires a short blast every minute to maintain flame on wick, and under this condition of operation, the unit has sufficient capacity for from 2 to 4 hours of operation on a single filling.

From test operations it appears that the most desirable operating range is from 40 to 60 pounds pressure. At this pressure range flame projection is adequate, flame characteristics are good, and sufficient fuel is deposited to help sustain fire.

The unit as a whole is lightweight, sturdy, and safe.

Of the pneumatic flame throwers tested to date this unit most nearly approaches the desired operating characteristics for this type of equipment. The present cost of the unit f.o.b. Arcadia is approximately $45. Further information on this unit may be obtained from the Arcadia Fire Control Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

THE ACTUARIAL METHOD OF FIRE SUPPRESSION PLANNING AS APPLIED TO TANKER DISTRIBUTION

RALPH L. HAND

Division of Fire Control, Region 1, U. S. Forest Service.

The Region 1 fire suppression plan is somewhat of a new departure in that it is based primarily on actuarial principles. The object is to determine the probable load in terms of the expected use of manpower, overhead, power equipment, transportation, warehousing, and all other elements that are necessary to do a satisfactory, economical job of fire suppression. The use of mass statistics has been eliminated in favor of the individual fire analysis and the calculation of mathematical betting odds has been selected in preference to the time-honored employment of averages which has long since proved meaningless in dealing with the various combinations of unpredictable conditions that make up the fire problem.

Three years ago, at the beginning of the planning project, it was decided that a cross-section sampling of 6 representative years of the previous 16 would be used in the individual fire analysis; the reason being that a long continuous run would be too costly and require too much time. This idea proved erroneous and the following year saw the conclusion of a 16-year run involving some 23,000 individual fires with no more than a couple of weeks required for the analysis on each individual forest. In this analysis, a post mortem was conducted on every fire—not to discover errors in the action as taken—but to reconstruct each particular fire in the light of the present day as regards physical conditions, policies, and a realistic view of the human element. Each fire was considered as to the practicability of using bulldozers, tankers, chain saws, trenchers, pumpers, smoke jumpers, or any other special equipment or techniques of suppression. In each instance where a fire was placed in a special category, certain information was calculated and recorded. This included time from the nearest logical base; percentage of line that could be machine built; and reduction in manpower, perimeter, and time of control by reason of the application of special equipment or methods.

The value of the analysis increases in direct proportion to the knowledge and practicability of those making the decisions and to maintain consistently high standards it is necessary to insist that top fire control men from each forest be given a leading part in the planning for their unit. To insure uniformity, a fire planning specialist from the regional office likewise participates on every unit. Obviously, it is necessary to eliminate from the record those fires in which the specific cause no longer exists in that particular area.

The application of the findings, as determined from the analysis, requires separate treatment for each of the various categories and each has its peculiar problems. The Region 1 Tanker Plan is used to illustrate the planning principles, mainly because the practical application of this plan has progressed somewhat farther in this than in planning other elements. The tanker fire problem is largely localized, and the assignment of this type of equipment relatively cheap. There are no serious problems of interforest assignment or costly transport considerations as with bulldozers, for example.

THE TANKER PLAN

The tanker plan is one of the major sections of the Region 1 Fire Suppression Plan. It was designed for the purpose of determining the extent to which tankers and all types of water-carrying equipment are needed in the region, their proper distribution, and the economy of their use compared to other fire control methods. It evaluates the problem by localized areas and determines priorities of the many prospective bases from such factors as probable occurrence of fires on which tankers should be used; volume and dispersion of fast-spreading fuels; degree of vulnerability of the area to damaging fires; accessibility to water-carrying equipment; recent occurrence trends and probable future increase or reduction in hazards.

The plan is to be used in the transfer and assignment of tankers and water carriers and as a guide in directing new developments and purchases. It provides a method by which tanker production records can be kept and used to determine the amount that we can afford to invest in this type of firefighting equipment.

THE ANALYSIS

The expectancy in rate of occurrence and seasonal duration and the hour-control data from the various bases was determined by means of the analysis of individual fires which resulted in the classification of 3,088 tanker chances out of a total of more than 23,000 fires.

It is realized that occurrence, even when adjusted to meet changed conditions, and with full consideration for recent trends, is but a single factor. The fuels that exist within those areas that are accessible to tanker equipment—the potential hazards introduced by either dense concentrations or widespread areas of fast-spreading types are at least equal if not more important, according to the degree in which they add to the possibility of costly and damaging fires. Maps were prepared by those forests that had considerable areas of slash, outlining them in as much detail as possible, and this data was supplemented by specific information gained from those individuals who had intimate knowledge of actual conditions on the ground. Smelter-fume, bug, disease, blow-down, and frost-kill were treated the same way, to the extent that they affected the situation regarding tanker use. Extensive grass areas, particularly cheatgrass slopes, were given full consideration with the greatest emphasis on potential damage rather than probable burned area.

Accessibility was determined mainly by the study of "tanker road tracings" which outline the usable roads within those areas of appreciable man-caused fire occurrence and indicate the amount of operable area. Also, time estimates were made for each individual tanker fire in relation to specified bases.

PROSPECTIVE TANKER BASE RATING SYSTEM

Add the numerical ratings from each category below to determine the final combined rating.

Occurrence.—Rate: Normal expectancy in number of fires per year.

Trend: Pronounced up or downward recent trends expressed as plus or minus; add or subtract 1, 2, or 3 to or from base rate according to degree.

Heavy Fuels.—Rate: Expressed as 1, 2, 4, and 8, for low, medium, high, and extreme, in conformity with the progression used in Region 1 in all phases of fire planning. Emphasis placed on probability of costly and damaging fires that might occur from delayed action, rather than danger of fires starting in such areas, although both factors are considered.

Trend: Best judgment available as to prospects of the immediate future expressed as plus or minus; add or subtract 1, 2, or 3 to or from base rate.

Grass fuels.—Expressed directly as 1, 2, 3, or 4, to represent low, medium, high, and extreme. In this case, too, potential cost and damage is given the edge over prospect of fires starting in such fuels.

Accessibility.—Road: Rating of 1 or 2 given according to degree of accessibility as indicated by extensiveness of the road network to cover the danger areas.

Nonroad: Rated 1 or 2 additional to show value of the base where four-wheel-drive equipment can cover areas beyond the road system.

Hour control.—Thirty-minute and one-hour control given a rating of 1 each, if 50 percent of the tanker fires allocated to the base can be reached in 30 minutes; 90 percent in 1 hour.

CLASSIFICATION OF TANKER BASES

Prospective tanker bases are grouped in four major categories as follows:

Class A or primary base.—Must be of sufficient importance that the combined occurrence, hazard, and risk warrants assignment of a high-grade, standby unit, designed as a single-purpose fire truck. Numerical rating 15+.

Class B or secondary base.—Of lesser importance than class A as determined by rating of occurrence, fuels, potential cost and damage, and other pertinent factors, but still justifies assignment of second-rate standby or first-class demountable equipment. Numerical rating 11 to 14.

Class C or utility base.—Rates below class B but still justified for tanker equipment that can be developed at moderate cost and used in combination with other activities in the out-of-fire season. Numerical rating 7 to 10.

Class D or provisional base.—Lowest rated base. Must justify assignment of water-carrying equipment in combination with need for regular transportation of fire-goers. Numerical rating 5 and 6.

The above classifications are for the purpose of grouping bases according to relative importance. Mechanical standards for tankers regarding speed, power, water capacity, etc., are another matter and should not be confused with the base categories. While most primary or class A bases will justify assignment of a prime, standby tanker, it does not necessarily follow that all grades of equipment will fall in line with the base assignments. A few relatively low rated class C bases may require heavy-duty equipment because of the nature of fuels, while other higher rated bases may warrant low-capacity, dual-use units. Four-wheel versus conventional drive is also a matter of efficiency according to the nature of the area covered by the particular base and is in no way connected with the importance as determined from the numerical rating.

On the above basis, Region 1 analyzed 105 prospective tanker bases of which 65 were given ratings of 5 or over. Fourteen made the primary, 17 the secondary, 24 the utility, and 10 the provisional grade. Seventeen tankers have been assigned since the initial rating was completed and it is expected that 9 more will be placed next spring.

A continuation of the analysis to cover three more years (1947, 1948, and 1949) will be completed this winter at a cost of approximately 3 man-days per forest and all bases will be rerated according to the latest findings. Thereafter, it is expected that the recalculation and rating will be done annually in order to keep abreast of changes in conditions and be assured of the best possible distribution of power equipment and specialized services.

INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed on a strip of paper attached to illustrations with rubber cement. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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FIRE CONTROL NOTES

A PERIODICAL DEVOTED
TO THE TECHNIQUE OF
FOREST FIRE CONTROL

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE

FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 11 Number 2

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The printing of this publication has been approved by the Director of the Bureau of the Budget (May 17, 1948).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1950

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NEW FIRE PUMPERS TESTED

ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER

Region 5, U. S. Forest Service

In accordance with the procedure adopted for qualifying pumps as suited for forest fire service, the Arcadia Fire Control Equipment Development Center has conducted performance tests on the three portable pumps described below.

UNIT 1

This unit, U. S. F. S. Region 5 Model 47 Portable Pumper (specification revised October 1947), consists of a pump, engine, base, and carrying handles (fig. 1). It has a dry weight of 96 pounds, and its over-all dimensions are 24 inches long, 16½ inches wide, and 20 inches high.

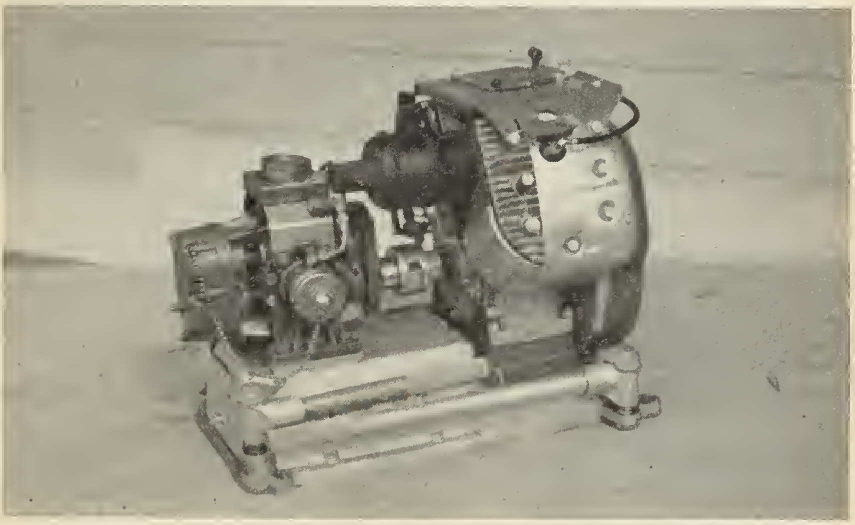


FIGURE 1.—Unit 1: U. S. F. S. Region 5 Model 47 Portable Pumper.

Performance ratings with 3-foot suction lift are as follows:

Discharge pressure (pounds per square inch):	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	25
100	22½
250	18
310	16

The engine is a single cylinder, air-cooled, 4-stroke cycle gasoline type, rated 6 horsepower at 2,700 revolutions per minute (r. p. m.), and is equipped for rope starting. Ignition is by an impulse type magneto. Fuel used is commercial grade gasoline of approximately 70 octane supplied from an auxiliary tank by fuel pump. Fuel consumption is approximately 0.5 gallon per hour when operating at normal conditions of 18 gallons per minute (g. p. m.), 250 pounds per square inch (p. s. i.), and 2,900 r. p. m.

SAE 30 detergent type oil is used in the engine crankcase, which has a capacity of 3 pints.

The pump is a positive displacement gear type with pilot gears. This particular model has aluminum end cases, monel metal wear plates, and bronze impellers on stainless steel shafts. Connection of the pump to engine is direct through a flexible coupling.

Standard accessories include the following:

Built-in tool compartment in base.
Guard plate on which engine controls are mounted.
Pressure gage, 0–500 p. s. i.
1 gasoline tank, 4-gallon.
1 gasoline hose, 5-foot.
2 starter ropes.
1 oil measure.
1 grease gun.
1 can bearing grease.
1 spark plug (extra).
1 spark plug wrench.
1 point feeler gage.
1 packing gland wrench.
1 pliers, 8-inch.
1 screw driver, 6-inch.
1 crescent wrench, 6-inch.
1 crescent wrench, 8-inch.
2 spanner wrenches, forestry lug.

Performance of this pumper compared with the specifications, revised October 1947, as follows:

Specification:	*Test results*
Maximum weight, less accessories: 100 pounds	96 pounds.
Maximum dimensions: basal area, 3 square feet; height, 20 inches.	2.67 square feet, 20 inches.
Vacuum when new: not less than 20 inches Hg. (mercury) with unit dry and at governed normal r. p. m. specified by manufacturer.	20 inches Hg.
Vacuum after 100 hours: not less than 15 inches Hg. with unit dry and at governed normal r. p. m. specified by manufacturer.	15.5 inches Hg.
Normal output: 18 g. p. m. at 250 p. s. i. with 3-foot suction lift and at governed normal r. p. m. specified by manufacturer.	18.45 g. p. m.
Maximum output when new: not less than 16 g. p. m. at 310 p. s. i. with 3-foot suction lift and full throttle.	16.8 g. p. m.
Maximum output after 100 hours: not less than 15 g. p. m. at 300 p. s. i. with 3-foot suction lift and full throttle.	16.6 g. p. m.

Cost of the pumper complete with listed accessories, f. o. b. San Francisco, was $528 as of June 1946.

UNIT 2

Subsequent investigation toward securing a more economical unit in the same performance class has resulted in the manufacture of a cheaper model with identical performance characteristics (fig. 2).

This unit, U. S. F. S. Region 5 Model 47 Portable Pumper (specification revised July 7, 1949), is essentially the same as that shown in figure 1. The main differences are a reduction of accessories, simplified base and porter bars, elimination of the engine control guard plate, and change of materials used in the pump.

This pump has an aluminum pilot gear cover and a stainless steel shaft, but is otherwise all bronze. Where difficulty due to either corrosion or electrolytic action can be expected, the bronze unit is to be preferred.

Standard accessories include:

1 pressure gage, 0–400 p. s. i.
2 starter ropes.
1 grease gun.
1 spark plug wrench.
1 set, magneto and breaker point adjusting tool and spacer gage.
1 packing gland wrench.
1 pair pliers, 6-inch combination.
1 screw driver, 4-inch.
2 instruction books.
1 extra set of spark plugs.

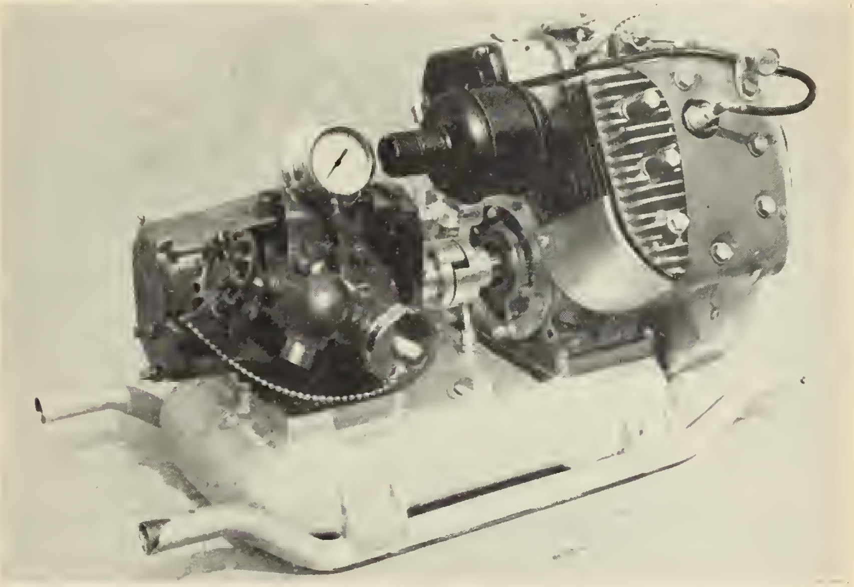


Figure 2.—Unit 2: Lower Cost U. S. F. S. Region 5 Model 47 Portable Pumper.

Performance of this pumper compared with the specifications, revised July 7, 1949, as follows:

Specifications:	*Test results*
Maximum weight: 130 pounds	100 pounds.
Maximum dimensions: basal area, 3 square feet; height, 20 inches.	2.67 square feet, 20 inches.
Vacuum when new: 20 inches Hg. minimum	20 inches Hg.
Vacuum after 100 hours: 15 inches Hg. minimum.	15.5 inches Hg.
Normal output: 18 g. p. m. at 250 p. s. i. minimum.	18.45 g. p. m.
Maximum output when new: not less than 16 g. p. m. at 310 p. s. i.	16.8 g. p. m.
Maximum output after 100 hours: not less than 15 g. p. m. at 300 p. s. i.	16.6 g. p. m.

Cost of the pumper, complete with standard accessories as listed, as of August, 1949, is $365 f. o. b. San Francisco.

It appears, after extensive investigation of possible applications of low-pressure fog and wet water, that a pump in this capacity range is to be recommended as being better suited for general service than units having lower discharge rates at lower discharge pressures. Details of the results of these studies are expected for release in an early issue of Fire Control Notes.

UNIT 3

This unit consists of a pump, engine with accessories, base and carrying handles (fig. 3). It has a dry weight of 190 pounds, and its dimensions are 29 inches long, 22 inches wide, and 21 inches high.

Performance ratings are as follows:

Discharge pressure (pounds per square inch):	*Discharge rate (U. S. gallons per minute)*
0 (free discharge)	45
100	40
250	30
310	25

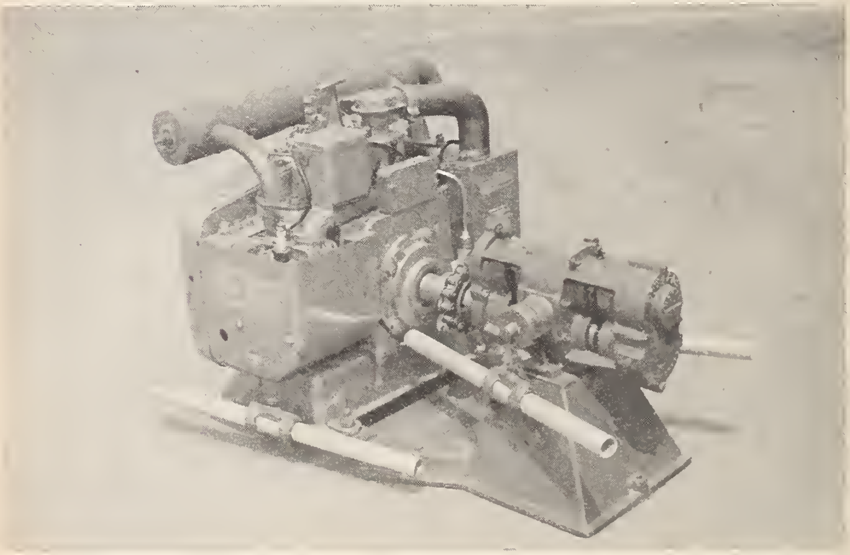


Figure 3.—Unit 3: U. S. F. S. Region 5 Model 49 Portable Pumper.

The engine is an air-cooled, opposed twin cylinder, 4-stroke cycle, L-head gasoline type, rated at 10 hp. at 2,700 r. p. m. and is equipped with a 12-volt electric starter-generator system provided for rope starting in an emergency. Commercial grade fuel, approximately 70 octane, is used, and is supplied from an auxiliary 5-gallon tank and fed to the carburetor by a fuel pump. Fuel consumption is approximately 1 gallon per hour when operating at normal rated load.

SAE 30 detergent type oil is used in the engine crankcase, which has a capacity of 2 quarts.

The pump is a positive displacement gear type, rated 30 g. p. m. at 250 p. s. i., at 2,600 r. p. m., and is equipped with chevron packing held in place by gland nuts which need be hand tightened only. Pump bearings and pilot gears are packed with grease and require service once annually. Connection of the pump to the engine is direct through a flexible coupling.

Standard accessories include:

Adjustable carrying handles.
1 pressure gage, 0–500 p. s. i.
1 starter rope.
1 extra set spark plugs.
1 spark plug wrench.
1 packing gland wrench.
1 pair pliers, 6-inch combination.
1 screw driver, 4-inch.
1 set, magneto and breaker point adjusting tool and space gage.
1 crescent type wrench, 10-inch.
1 canvas tool kit.
1 can grease, 1-pound, suitable for packing gland and bearing.

Performance of portable pumper, U. S. F. S. R–5 Model 49, compared with specifications, revised March 23, 1948, as follows:

Specifications:	*Test results*
Maximum weight: 200 pounds	190 pounds
Maximum dimensions: 34 by 24 by 22 inches	29 by 22 by 21 inches
Vacuum when new: 20 inches Hg. minimum	22.5 inches Hg.
Vacuum after 100 hours; 15 inches Hg. minimum	16 inches Hg.
Normal output: 30 g. p. m. minimum at 250 p. s. i	31.5 g. p. m.
Maximum output when new: not less than 25 g. p. m. at 310 p. s. i	25.35 g. p. m.
Maximum output after 100 hours: not less than 23 g. p. m. at 300 p. s. i	23.03 g. p. m.

Cost of the pumper complete with listed accessories, f. o. b. Arcadia, Calif., was approximately $585 as of April 1949.

This unit is more suited for the large tanker or slip-on installations, or for areas where higher pump capacity is essential to effective control. While the electric start feature is a decided advantage, it should be recognized that a 12-volt system is required, thereby adding approximately 115 pounds extra weight. If desired the pumper is available without electric start at $480, as of April 1949.

Specifications covering these pumper units as well as details regarding tests and performance are available at Arcadia Fire Control Equipment Development Center, 701 North Santa Anita, Arcadia, Calif.

Woods Burner's Waterloo.—The following filler, taken from a recent issue of Bois et Resineux, explains what must have been a very effective forest fire control program in Napoleonic France.

In 1808 Napoleon I wrote one of his prefects the following letter:

Monsieur le Prefet, It has come to my attention that numerous forest fires have broken out in the section I have entrusted to your administration.

You are hereby ordered to have anyone guilty of starting fires shot at the scene of the fire. Furthermore, if fires continue, I will make arrangements to have you replaced.

Napoleon.

—Reprinted from Naval Stores Review.

USE OF PORTABLE FIRE PUMPER DURING SEPTEMBER 1932

PAUL H. RUSSELL
Assistant Supervisor, Nantahala National Forest

[The following article, written by P. H. Russell 17 years ago, has been included in this issue because it may be of interest to fire control men concerned with the development and use of portable pumps.—Ed.]

During the latter part of August 1932 a small fire occurred in the Cedar Run section of Summerhill Township, Cambria County, Pa., and was thought to have been completely extinguished. On September 8, this fire broke out and burned over a large part of an old dried out swamp. The fire was brought under control during the evening of the first day. Beaver Run ran along the west side and Cedar Run ran diagonally through the burned area. It was decided that on the following morning a portable fire pumper, which was lying in storage, should be rigged up and used. A crew, composed of four reliable men, was organized to operate the pumper and arrangements made for the use of a truck to transport the equipment. On the morning of September 9, the pumper started working on the Cedar Run fire. After 3 days on the Cedar Run fire, the pump was moved wherever it could be used. From September 9 until September 23 it was used every day except one and saw service on five fires.

Actual running time on the five fires was as follows:

Fire:	*Running time (hours)*	*Area burned (acres)*
Cedar Run	91	60
Summerhill	12½	6
No. 6 Schoolhouse	10½	5
Summit Country Club	1	½
Ebensburg	13	40

Thus, during the 2-week period, the pump worked a total of 128 hours, consuming 134 gallons of gasoline and 52 quarts of oil, and throwing approximately 15,000 barrels of water.

On an average the pump consumed 1.048 gallons of gasoline and 0.406 quart of oil per hour. With the total cost of the crew and transportation at $399.77, the gas and oil at $69.44, and a depreciation of $2 per running hour, the average cost per running hour would be as follows:

	Cost per running hour (dollars)
Crew and transportation	3.12
Gas and oil	.54
Depreciation	2.00
Total	5.66

The extremely dry period of September, with the conditions such that it was very difficult to completely extinguish fires, provided an excellent opportunity to try out the pumper. Several interesting observations were made.

On each of the first several days the pump was used, there could be noticed a considerable increase in the efficiency of the operating crew. This was due to the increasing familiarity with working details of the pump and hose and the use of water to the best advantage.

It was also shown in convincing manner, especially on the Cedar Run fire, that the pumper will not serve as a substitute for a well-constructed line. There were six breakouts on the Cedar Run fire that burned more than one-tenth of an acre. Only two of these breakouts were controlled by the pump without putting in a good line. One breakout was controlled by use of the pump before the middle of September when the fire still burned very slowly. The other breakout was controlled by the pump after the middle of September when fires burned as fast as a spring fire, and then only because the pump happened to be placed in an advantageous position and hose already partly strung out so that the breakout was fought before it had reached a size of more than one-fourth of an acre. The conclusion is that, unless the pump is already advantageously placed and plenty of hose immediately available, it is almost impossible to stop a fast running fire with the pump alone. This is due to the fact that the pump and a long stretch of hose cannot be moved fast enough.

On the Paddy Meadow fire, all but two breakouts occurred after the edge of the fire in to a distance of 40 feet had been completely wetted down for hours at a time. In one instance, the pump forced water on a small breakout for more than 3 hours on three separate occasions and yet, a day later, the largest breakout of the fire started from this same area. On the basis of a cost of $5.66 per hour to run the pump, this would be the equivalent of about 16 man-hours. There is a question as to whether in many situations the pump will do more than its equivalent in manpower, but under ordinary conditions it is undoubtedly more efficient in mopping up and is fairly convenient.

PROGRESS ON PROPOSED FOREST SERVICE STANDARD SLIP-ON TANKERS FOR ¾- AND 1-TON VEHICLES

Arcadia Fire Control Equipment Development Center
Region 5, U. S. Forest Service

One of the Service-wide development projects assigned to the Arcadia Fire Control Equipment Development Center was the design and construction of a medium-weight slip-on tanker to fit pickup and express bodies of ¾- and 1-ton trucks, and which would meet the varying needs of all Forest Service regions.

In order to incorporate the most desirable features, suggestions and requirements were solicited from field men and many existing units were inspected in several regions. Information thus secured clearly indicated that the objective was the construction of a versatile unit, with the component parts so designed and mounted that alternate positions for pump, reel, and tool box and a reasonably wide selection of pumpers were possible. Furthermore, water capacities should be provided consistent with proper loading of either the ¾- or 1-ton vehicles and for either mountain or flatwoods operation.

The first unit designed and reported upon herein is for mountainous areas (fig. 1). A skid frame cradles the 125-gallon water tank and a watertight equipment compartment which can be used as a container for an additional 75 gallons of water when a 1-ton vehicle provides transportation.

The slip-on tanker is secured to the vehicle by means of four chains attached to the top of the frame. At the ends of the chains are hooks which engage eye bolts mounted in the bed of the vehicle.

On the top of the skid frame a rectangular base, supporting the reel and pumper, is attached by means of four bolts. This allows for reversing position of reel and pumper. And since, in plan view, the unit is square the user has a choice of eight different arrangements of reel, pumper, and tool box location when installing the unit in a vehicle.

The dry unit with pumper and reel, but without tools and equipment, weighs 623 pounds. The loaded unit, with tools and equipment as listed further in this article, weighs 1,910 pounds.

Water tank.—The water tank is 47 inches long, 30 inches wide, and 20 inches high, constructed of 14-gage black iron, and divided into four compartments by baffle plates. The entire top is removable to facilitate cleaning. The interior of the tank is treated with a sanitary rust preventive compound. Two sets of tank outlets are provided on the lid to allow for reversing positions of pumper and reel. These serve for fill spout, outlet for suction line from tank, tank vent, and relief valve discharge to the tank.

Equipment compartment.—Mounted alongside the water tank is a watertight box 47 inches long, 16¾ inches wide, and 21½ inches high, which serves as a tool box or as an auxiliary water tank (fig. 2).

For the purpose of safety, cutting tools are mounted on underside of the lid. Long-handled tools and suction hose may be mounted as desired, either on the unit or on the vehicle.

When a ¾- or 1-ton vehicle carrying the slip-on is operating on level highway, or at slow speeds on the fire, the tools and equipment can be removed from the equipment box, which can then be used for carrying an additional 75 gallons of water. Water is drawn from this compartment by means of the overboard suction hose. Revisions in the tank which will permit cheaper construction and eliminate the necessity for using the suction hose to draft from equipment box are planned.

Pump and reel frame.—The pump and reel frame is 50¾ inches long and 21 inches wide. Sufficient space is provided on the frame for mounting a hose reel 23 inches long and 21 inches in diameter. The space and installation facilities for the pumper permit the use of several different makes and models of portable pumpers now manufactured.

Pumper.—The pumper unit, which was installed on the pilot model, and illustrated in figure 1, has a rated capacity of 18 gallons per minute at a pressure of 250 pounds per square inch. It is of the positive displacement gear type and weighs 96 pounds. The engine is an air-cooled 4-stroke cycle gasoline type, rated at 6 horsepower at 2,700 revolutions per minute and is equipped for rope starting only.

Reel.—The high-pressure live hose reel will carry 250 feet of 1-inch cotton-jacketed rubber-lined, or ¾-inch high-pressure rubber-covered

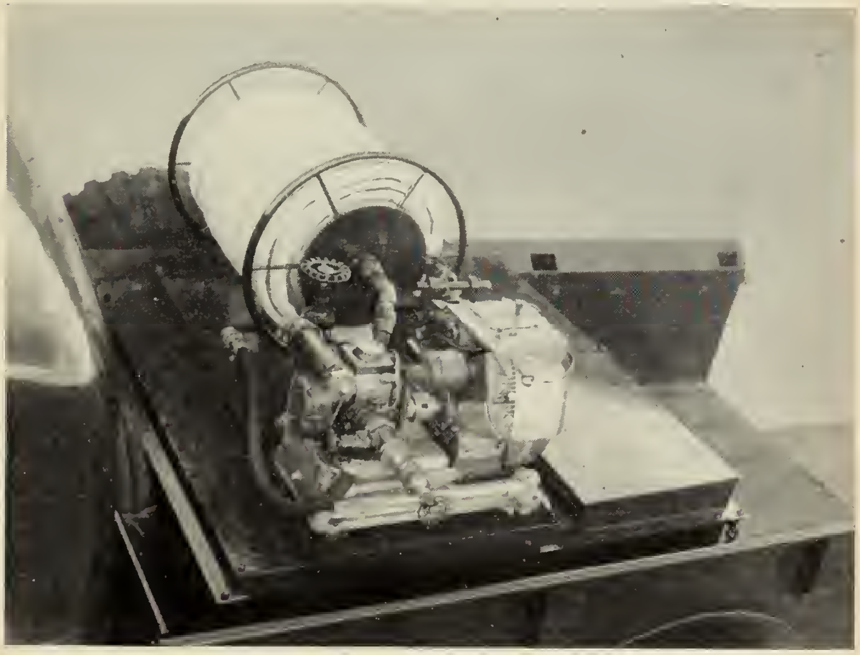


FIGURE 1.—Mountain type slip-on tanker for ¾- to 1-ton vehicles.

hose. The reel is equipped with a quick-throw friction drag brake and a geared crank for winding in the hose.

An alternate reel arrangement, consisting of either one smaller reel or two reels in the same space and equipped for small-diameter hose ($\frac{7}{16}$-inch or ½-inch), is being considered.

Equipment.—One typical list of equipment is as follows:

250 feet—1-inch CJRL hose on reel
250 feet—1-inch CJRL hose
200 feet—1½-inch CJRL hose
20 feet—1-inch suction hose
1—5-quart gasoline tank (full)
2—shovels, No. 0
1—ax
1—brush hook
1—Pulaski
1—McLeod tool

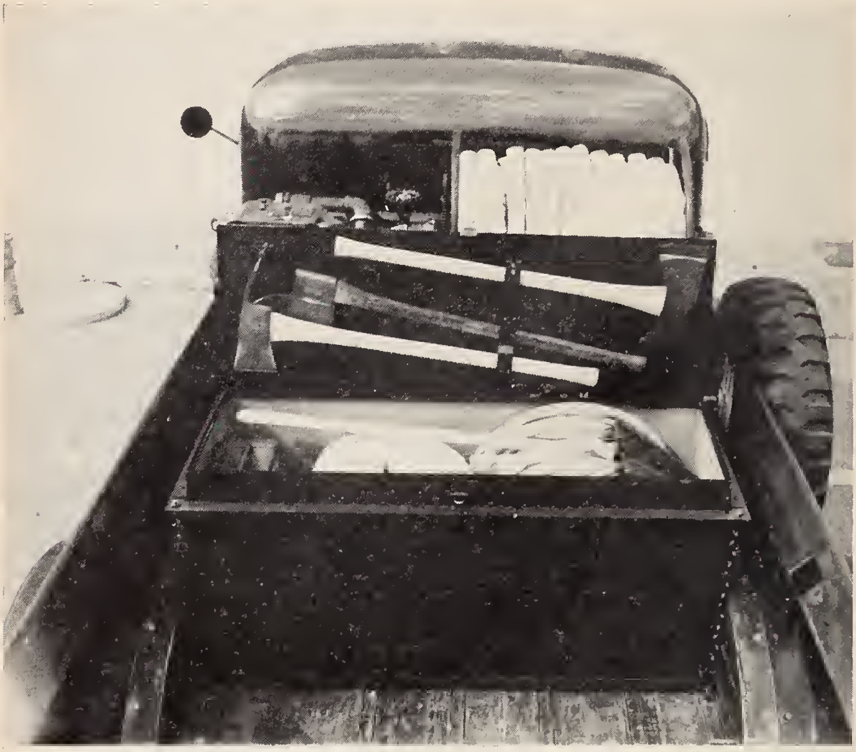


FIGURE 2.—Tools and hose arranged in box.

Since tools and equipment vary somewhat according to the user's choice, no specific brackets or tool racks are included on the proposed standard unit, but would be obtainable as accessories.

Radio installations.—When the slip-on tanker is to mounted in the vehicle with tool compartment to the rear and reel and pumper in line across the bed, suitable space is provided across the back of the cab and above the tank for a mobile radio installation having remote controls in the cab.

Cost.—Estimated cost of the slip-on tanker, equipped with Region 5 Specification Model 48 Pumper but without accessories, is approximately $800. Information received from one manufacturer would indicate an eventual cost of about $650, if produced in quantity.

Thirteen units have been constructed and a few are now in experimental use in the field. Reports and comments on the unit to date have been very favorable.

Future work.—Following the completion of the mountain and flatwoods models a detailed report with photographs fully illustrating the versatility of the units will be made available to Forest Service regions and to State, private, and other Federal forest protection agencies for review and comment. Such reasonable changes as are essential to meet the needs of the interested agencies will then be made and the final proposal submitted as standard items of equipment for the Forest Service. If the resulting unit is satisfactory for adoption as standard by other agencies a reduction in the cost per unit can be expected.

Spiral Rotor Trencher—Preliminary Performance Report.—The January 1949 issue of Fire Control Notes describes the spiral rotor trencher designed and constructed in Region 6. Two of these units are being tested for performance on the Sierra and Trinity National Forests of Region 5, under procedures outlined by the Arcadia Fire Control Equipment Development Center. The purpose of the test is to determine the varying types of terrain, cover, and soils in which the machine can be operated as well as to bring out any weak spots in the mechanical construction of the equipment. The following is a brief summary of observed results to date:

Timber type.—The rotor trencher produced an excellent fire line in all types of duff encountered, whether composed of needles from pine or fir, or leaves from hardwood species. A fire line 18 inches wide was cut to mineral soil. A 6-inch berm on each side, composed of duff and dirt, added to the effective width. The trencher is able to push limbs, poles, and rotten logs aside so that very little advance clearing is necessary. Single-pass fire line is built at the rate of approximately 1 mile per hour.

Open-grass type.—Grass type, as a rule, proved the most difficult, because of the hard baked soil underneath. In one area a fire line 18 inches wide was constructed in which the grass was stripped off and very little dirt was moved. In contrast to this, where the soil was less firm, a 20-inch line in mineral soil was built, plus an 8-inch berm on each side, composed of grass covered with dirt, giving a 36-inch effective fire line.

Operating up a 20-percent slope, fire line was constructed at a rate of 0.92 mile per hour. Down the same slope, line was built at the rate of 1.24 miles per hour.

Bear clover.—The rotor trencher had no difficulty building a 19-inch line in bear clover, at a rate of three-quarters of a mile per hour. It could climb and build fire line up to a 50-percent grade in this type cover.

Mixed chaparral.—The rotor trencher was not designed to cut brush, but it was found a useful tool in this type, to build fire line around and underneath the brush by "worming" its way around obstacles. With a minimum of clearing in advance a good job can be done on "cold-trailing" in brush types.

Chamise type.—The rotor trencher is capable of building fire line in this type, since the stems are brittle and root systems are not too substantial. However, going is rough on both the machine and the operator.

Terrain.—Rocks up to 5 inches in diameter are readily handled by the trencher if they are in loose soil. Rocks imbedded in hard soil cannot be moved and should be avoided when possible. However, the machine is able to slide around the obstacles without too much abuse to the machine.

Fire line was built on side slopes up to 45 percent without difficulty when the surface was smooth.

The spiral rotor trencher shows promise of general adaptability to line construction in most fuel types. As in all new designs mechanical failures have been encountered. Difficulties in carburation on side slope and slipping of belts in the steering mechanism are problems that will require revised design. The principle of the spiral rotor for line construction, however, has definitely been proved to have merit.

Conclusion of the tests is scheduled for approximately January 1, after which a complete report covering rates of construction, grades, and fuel types to which the machine is adaptable will be made.—ARCADIA FIRE CONTROL EQUIPMENT DEVELOPMENT CENTER, *Region 5, U. S. Forest Service.*

SLIP-ON CONVOY LUBER AND FUEL UNIT

Arcadia Fire Control Equipment Development Center

Region 5, U. S. Forest Service

One of the 1948 Service-wide projects assigned the Arcadia Development Center was a slip-on convoy luber and fuel unit to service fire camp equipment and trucks on fire lines away from roads. Such a unit has been built and tested, and is reported briefly in the following:

The unit is designed to fit a ½- or ¾-ton pickup, but can be used in 4 x 4's or 1½- to 2-ton stakesides, as well as in the multi-purpose tractor-drawn trailer, described in the April and July 1948 issue of Fire Control Notes, Vol. 9, page 31.

The luber consists of a gas engine driven compressor and air storage tank, two pressure lubrication pots, and a tool box mounted on a skid frame (fig. 1).

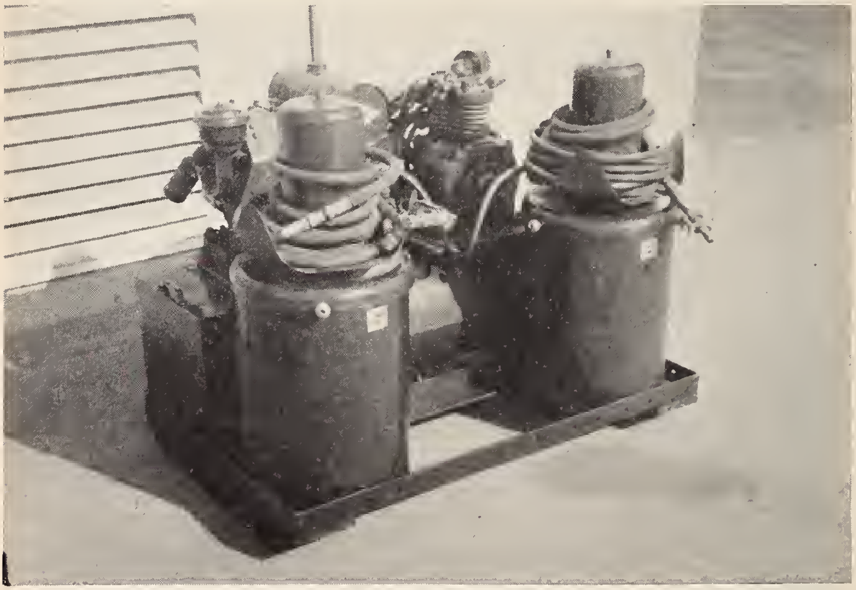


Figure 1.—Slip-on luber.

The over-all dimensions are 3 feet 9 inches long, 2 feet 5 inches wide, and 3 feet 1 inch high. The two-stage compressor is belt-driven by a 4-cycle gas engine. The air tank is 12 inches in diameter by 36 feet long, built for a maximum operating pressure of 175 pounds. A pressure regulator and 24 feet of ¼-inch high-pressure air hose are provided.

The two lubrication pots have 100 pounds grease capacity each. One is provided for E. P. 90 gear lube and the other All-Purpose chassis lube. Each pot has 20 feet of high-pressure lube hose and a grease gun.

The tool box is 6 inches wide, 14 inches high and 14 inches long, and holds the grease fittings, air fittings, and the necessary hand wrenches and tools.

Estimated cost of this unit is $575, f. o. b., Arcadia. Weight is 625 pounds.

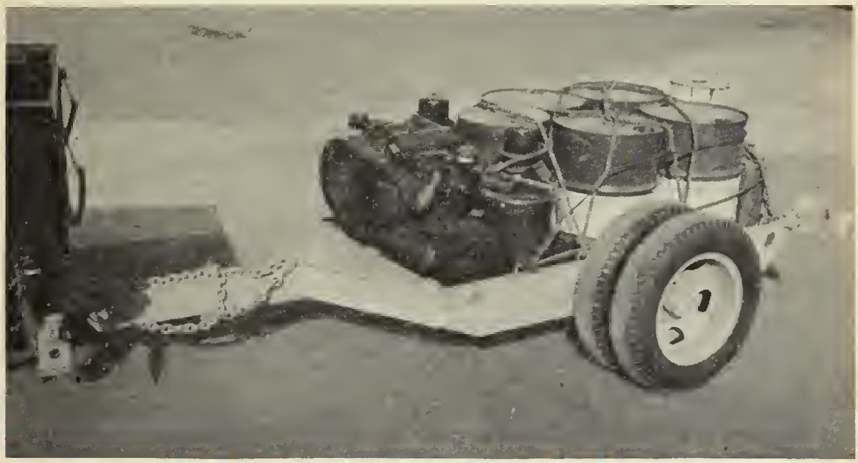


FIGURE 2.—Luber and fuel supply in utility trailer.

When this slip-on luber is used in the tractor-drawn trailer (fig. 2), four 55-gallon drums of Diesel fuel, one 30-gallon drum of water, one 15-gallon drum of motor oil, and two 5-gallon G. I. cans (one for cleaning solvent, the other for gasoline) can be carried.

The supplies noted are in about the right proportions, and have been used to service five D–7 or D–8 tractors for one 12-hour shift, or one D–7 or D–8 tractor for five 12-hour shifts.

The tool box on the trailer tongue will hold one oil measure can, one 5-ton jack, one taillight bracket, one clearance light bracket, one trailer hitch, 50 feet of ¾-inch manila tie rope, one barrel pump plus 10 feet of fuel hose, and some wiping rags.

The luber, plus the above load in the trailer, was designed to be pulled behind the tractor on its first trip into the working area. This saves the time of walking the tractor, or tractors, out to the road for servicing and back into the working area.

Plans and detailed construction drawings are available and may be obtained for all of the above described equipment from the Arcadia Equipment Development Center, U. S. Forest Service, 701 North Santa Anita Avenue, Arcadia, Calif.

[Since design of the luber there have been many versions of the convoy luber made available commercially. The Development Center will be glad to forward list of manufacturers and descriptive literature to any who may be interested.]

NEW PLASTIC TOWER PROTRACTOR

Neil LeMay

Chief Ranger, Forest Protection Division, Wisconsin Conservation Department

The Wisconsin Conservation Department is now starting its second year with the new plastic tower protractors, and to date the protractors have held their shape and accuracy and have stood up well under usage.

Prior to 1948 we used, with a few exceptions, paper protractors and maps mounted on Prestwood in our towers. We were constantly confronted with distortion due to mounting and with considerable replacement of the units. We tried to protect the mounted map and the protractor with glass covers, varnishing, etc., but still did not attain the desired results. As a consequence we searched for some other material for our protractor and for another method of providing the towerman a map that would not have to be replaced so frequently.

Investigation led to the selection of a plastic protractor 20 inches in diameter made of General Electric Textolite No. 2097 (fig. 1). The protractor was drawn to scale at our drafting office and was graduated in degrees and half-degrees with numbers every 10 degrees, running clockwise from zero to 360 degrees. From this the fabricating company prepared a plate and printed it on the face sheet of plastic, black on white. (This can be reversed if so desired.) This face sheet was then incorporated as a part of a laminated plastic structure to form a plastic sheet about 0.07 inch thick that is stable and practically indestructible. This was done at a cost of less than $2 per protractor in lots of 100. A 3/16-inch hole was drilled in the center of each protractor for fabrication purposes.

It was recommended by the fabricating company that these protractors be mounted on waterproof 7/8-inch plywood, using Cascamite or Weldwood with at least 50 pounds per square inch pressure, for the protractor unsupported has a tendency to warp though it does not change dimension. It was found that this mounting was easily accomplished with our shop hydraulic press, and as a matter of fact we used about double the required pressure and bonded as many as 30 protractors and bases at one time. We have had no failure in the cementing up to the present time, and it appears likely that none will occur.

To eliminate wear on the face of the protractor, plain black 10-inch diameter disks of Textolite (grade 10700 with black filler) were secured. They were placed on the protractor and served as a base for the alidade to ride on, keeping it just clear of the numbered edge of the protractor. The disks can be successfully cemented to the face of the protractor with Cascamite if desired.

The protractors were then carefully oriented in the towers by using azimuths from triangulation control data and securely fastened to the tower cabinet.

This arrangement prevented us from mounting a map with the protractor as we had done before, and so we are trying out the following map scheme. In place of the maps of ½-inch-per-mile scale that we formerly used, we have substituted our quadrangle maps, scale $^8/_{10}$ inch per mile, similar to the ones used by our dispatchers. The new tower maps have 6-inch protractors overprinted in red ink and are mounted on quarter board. They are composed to give about 15 miles coverage in all directions from the tower. Eyelets are inserted on each tower position on the map, as in dispatching maps, and either strings and weights or celluloid arms are used to cross up the fires. The maps are framed, varnished, and mounted so as to hinge up to the tower ceiling or against the side so that the map is protected except when actually being used. It is our hope that this system will give more service than our previous one and will also give more accurate information to the towerman.

For further information, such as source of supply of plastic disk, write to Chief Ranger, Forest Protection Division, Wisconsin Conservation Department, Tomahawk, Wis.

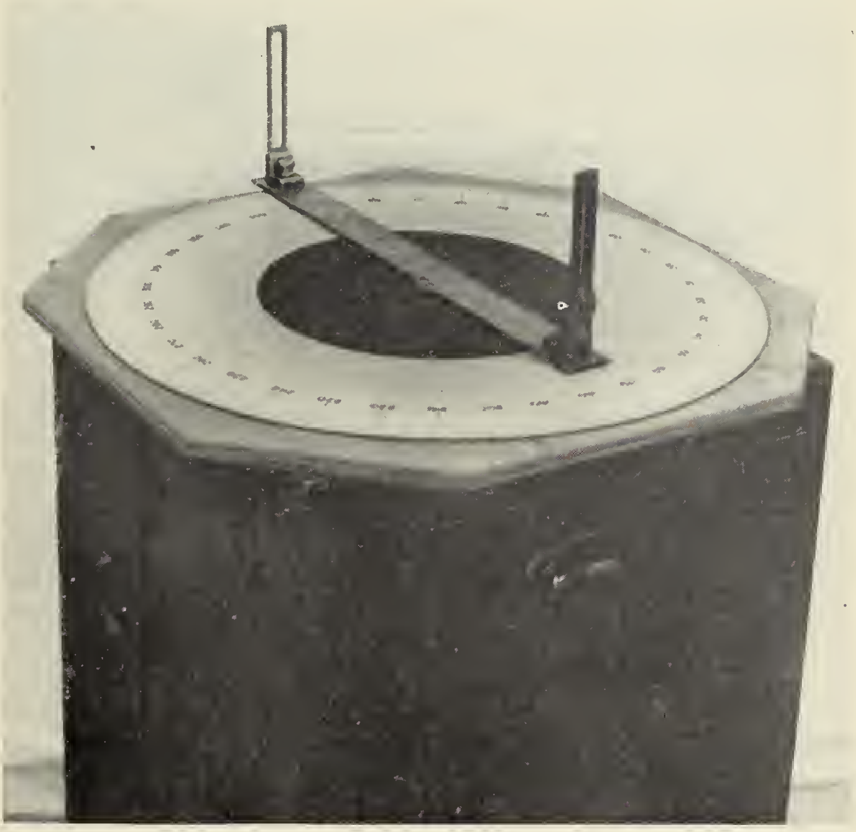


FIGURE 1.—Plastic protractor oriented and securely fastened to tower cabinet, showing riding position of alidade on Textolite disk. Protractor is 20 inches in diameter and is mounted on waterproof ⅝-inch plywood.

ARKANSAS FIRE FINDER

G. M. Conzet

Forester, Region 8, U. S. Forest Service

The Arkansas Division of Forestry and Parks is now equipping all of its towers with a new azimuth circle and alidade that are an improvement over the instruments currently used by many States. The project for developing this equipment was initiated and guided by Fire Control Chief R. M. Henry with the cooperation of Max Levine, instrument maker, and Carl Martin Manufacturing Co. of Little Rock, Ark. The equipment has been designed and built for simplicity and sturdiness as well as for ease and accuracy in operation.

The azimuth circle is 21 inches in diameter with 1-degree graduations and ½-inch figures stamped on aluminum plate $\frac{3}{16}$ inch in thickness and 24 inches in diameter. This makes a permanent rigid base and circle. In order to reduce glare to a minimum, the surface of this plate is coated with black wrinkled enamel sprayed on and baked. The stamped-in figures and degree marks are filled with phosphorescent paint to make them stand out better for both day and night reading.

The mounting of the aluminum plate and azimuth circle is by way of hinge-type guides attached to the under side. Opposite the guides are two leveling screws. The guides slide on a straight ¾-inch steel rod attached to a baseboard by brackets and bolts. The bolt holes for attaching the guides are slotted to provide for minor adjustments (as much as 5 degrees) when orientating the circle. There are 10 inches of lateral movement on the steel bar, which is sufficient to clear most tower cab obstructions in sighting. Opposite the slide bar and parallel to it is a flat iron bar bolted to the baseboard. This provides a true surface for the leveling screws. A center hub or pivot base with dowel, lock washer, and tension spring is attached to the center of the azimuth circle plate by four countersunk screws.

The main bar and sighting vanes of the alidade are of special high-strength, heat-treated aluminum riveted together permanently and finished with nonreflecting black paint.

All friction surfaces are of brass to prevent galling of those parts. The sighting vanes are 6 inches high and 18 inches apart. The bar and vanes are 1½ inches wide. The front vane has a vertical hair while the rear or near vane is slotted. This rear vane has a round opening close to the top and one near the bottom for coarser sighting or for use when light is poor. The rear end of the bar protrudes 2½ inches beyond the sighting vane, thus providing room for a circular opening 1¼ inches in diamter directly over the azimuth circle figures and through which the reading is made. To provide for accurate reading a black nylon index has been placed in this opening in direct line with the sighting parts of the vanes.

The azimuth plate is mounted with "O" azimuth to the south so that bearings may be read direct from the rear of the alidade.

Mr. Henry advises that manufacturers are now prepared to go into mass production. Prices from $15 to $37.50, depending on the number ordered, have been quoted. Inquiries for further information, including names of suppliers, should be addressed to R. M. Henry, Fire Control Chief, Arkansas Division of Forestry and Parks, Little Rock, Ark.

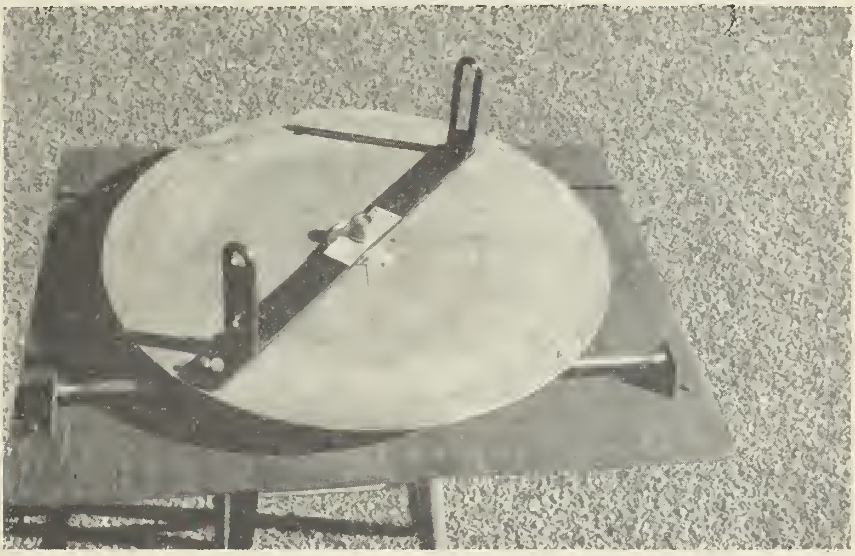


FIGURE 1.—Over-all view of the Arkansas fire finder before plate has been enameled and the figures and degree marks filled with phosphorescent paint.

IMPACT OF DESTRUCTIVE FOREST FIRES ON THE TIMBER RESOURCE OF A MANAGEMENT UNIT

C. A. Gustafson

Chief, Division of Fire Control, U. S. Forest Service

During 1945–47 a study of a management unit covering 1,689,400 acres of a major watershed was carried on to determine the total land area capable of supporting a stand of timber. A fire study was carried on simultaneously to determine the impact of destructive fires on the current timber producing capacity of the land, and to define that impact in economic terms.

An aerial photographic survey of the management unit provided the base for interpretation and determination of land capabilities. Sufficient field work was carried on to make sure that aerial photographs correctly interpreted can be used to classify land capabilities, particularly if those making the study are intimately familiar with the area. Other sources of material were fire reports, cut-over reports, cruise data, and management plans. Contacts with local people and others provided valuable information concerning fires that burned prior to 1905, at which time organized fire protection was begun, and immediately following 1905 when statistical fire data were not recorded in a completely satisfactory manner.

The land capability study of the management unit indicated that prior to the coming of the white man approximately 1,168,300 acres were covered with a stand of timber averaging about 20,000 board feet per acre (fig. 1). The total area of the unit was classified as follows:

Land capability:	*Acres*
Timber producing	1,168,300
Not suited to producing timber:	
Sagebrush and grass	39,000
Meadow	104,100
Lakes	3,000
Nonproducing[1]	375,000
Total	1,689,400

[1] Includes such areas as brush fields not capable of growing timber, land not suitable for agriculture nor supporting a stand of grass, rock outcrops, and barren land.

The fire study revealed that very few destructive fires occurred in the unit prior to the arrival of the white man. It is evident, however, that numerous lightning fires did occur although very few resulted in complete destruction of the timber stand. The total area on which the timber was destroyed by fire prior to 1905 was determined as slightly less than 50,000 acres.

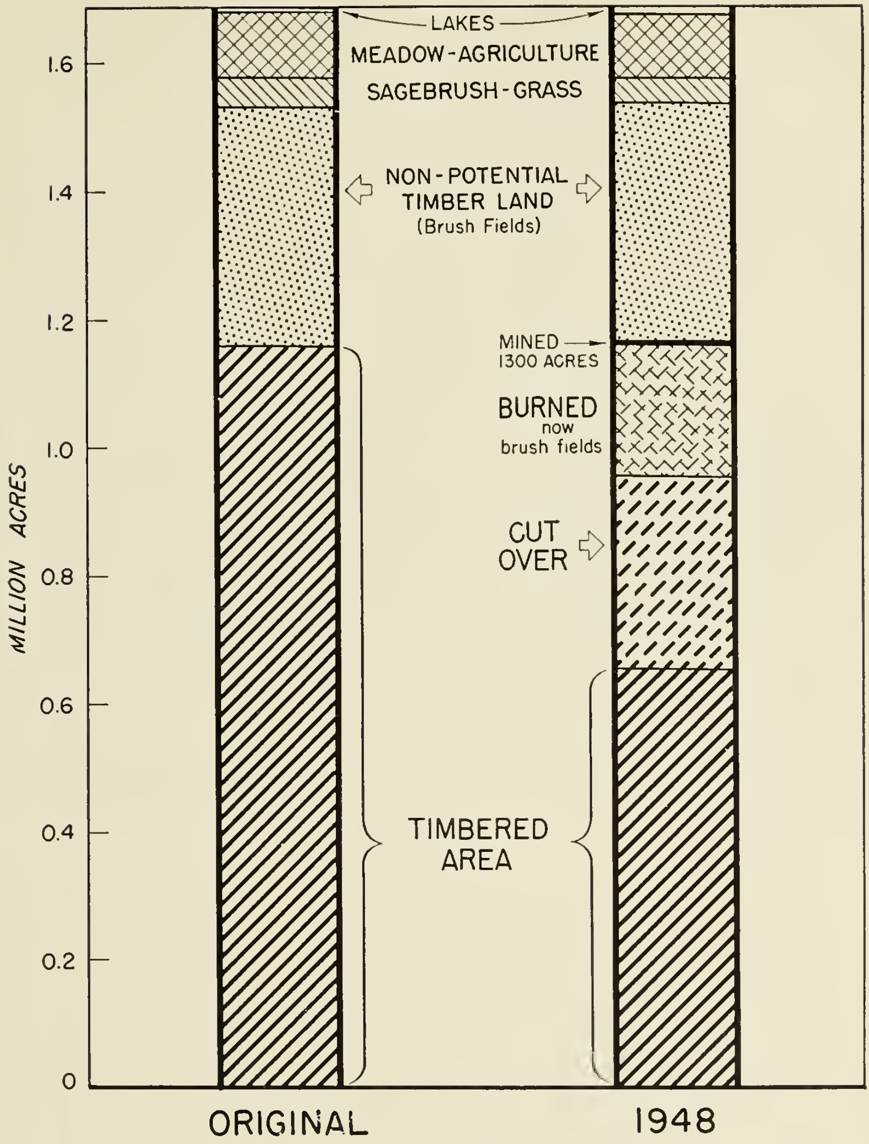


FIGURE 1.—Original timber resource situation as compared with that of 1948.

The aerial photographs were studied and the boundaries of destructive timberland fires were delineated on the map. These were confined to fires that crowned out, thus resulting in total kill of the timber stands.

Fire reports were studied to determine the year the original fire scars were made. After all available reports were considered, there remained a number of fire scars to which a date of origin could not be attached. Discussions with local people and others known to have worked in the area provided some helpful information. In this way the year and area of the destructive forest fires occurring within the unit after 1905 were determined (table 1). All fires previous to 1905 were lumped together.

The date assigned each of the destructive fires that resulted in a nonreproducing brush field was the date of the fire resulting in total destruction of the timber stand. There may have been fires previous to this date that burned over the area, but that did not get into the crowns and completely kill the timber. Also, there may have been some reburns of brush fields, but these were not cataloged since they did not result in the destruction of the original stand of timber.

Table 1 shows that 4.16 percent of the timbered area of the management unit was destroyed by fire previous to 1905. It also shows that during the 44-year period 1905–48 the fire-control organization failed to reach the area burned objective (one-tenth of 1 percent), except during 1940–44 when the average annual burn was kept to 0.092 percent. The percent of timberland burned was obtained by dividing the area burned during the period by the total area of timberland remaining at the beginning of the period. As the total timbered area decreased, the allowable burn objective in acres became smaller. For example, in 1905 it was 1,117 acres, while in 1949 it would be 958 acres. This type of calculation was used in determining the effectiveness of fire-control measures in the protection of the unit. Figure 2 shows the relative success or failure in protection, failure being considerable in the period 1905–34, success being approached or reached during the period 1935–44. It also shows that since 1944 the fire organization is again operating on the failure side of the burned area objective line.

Table 1 and figure 2 show rather conclusively that successful forest management is not possible for this unit, with the degree of protection that has been provided.

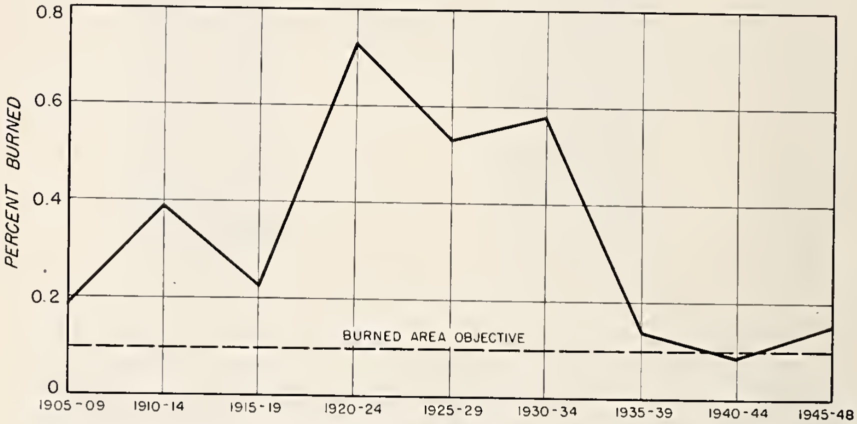


FIGURE 2.—Percent of timbered lands destroyed by fire, by periods, 1905–48.

A review of the condition of the management unit as of 1948 (fig. 1) showed that out of the original 1,168,300 acres of timbered lands, fire had brought about the formation of 209,000 acres of nontimber producing brush fields. The 209,000 acres on which the timber was destroyed is not a true measure of the total timberland burned over,

TABLE 1.—*Area of timber destroyed and percent of timbered area burned by destructive fires, by periods*

Period	Timber stands destroyed	Area remaining in timber at end of period	Timbered area burned	
			By period	Annual average
	Acres	*Acres*	*Percent*	*Percent*
Prior to 1905	49, 000	1, 117, 800	4. 16	
1905–09	10, 600	1, 107, 200	. 94	0. 188
1910–14	21, 500	1, 085, 700	1. 94	. 388
1915–19	12, 400	1, 073, 300	1. 14	. 228
1920–24	39, 300	1, 034, 000	3. 66	. 732
1925–29	27, 700	1, 006, 300	2. 68	. 536
1930–34	29, 200	977, 100	2. 90	. 580
1935–39	7, 100	970, 000	. 71	. 142
1940–44	4, 500	965, 509	. 46	. 092
1945–48	7, 500	958, 090	. 78	. 195

because many of the large fires did not go into the crowns. The figure represents the area of crown fires that resulted in a total destruction of the timber stands. Loss of increment due to ground fires must have been quite high, but there was no way to determine this loss from the data readily available. Mining, primarily in the form of hydraulic diggings, took another 1,300 acres of timberland out of production. Hence by the end of 1948 there remained 958,000 acres of land currently producing a timber crop. The situation at the end of 1948 was as follows (fig. 1):

	Acres
Timbered area (including virgin and cut-over areas)	958, 000
Potential timberlands (timber totally destroyed by fire, now brush fields)	209, 000
Nonpotential timberlands:	
Mining diggings	1, 300
Sage brush and grass areas	39, 000
Meadow and agricultural land	98, 000
Lakes	9, 100
Brush fields, rock areas, etc	375, 000
Total	1, 689, 400

A review was made of the 14 most destructive fires occurring in the 44-year period 1905–48. These 14 fires destroyed about 85,000 acres of timber, or approximately 53 percent of the total area destroyed since 1905. They were all extra-period fires, thereby emphasizing the need for early aggressive attack on all fires starting during periods of high fire danger and for employing the best skill possible in their control. The years in which the most destructive fires occurred were 1905, 1910, 1918, 1924, 1926, 1931, and 1934, with 1924 probably the worst, followed by 1926 and 1934.

Destructive fires on this management unit have resulted in the loss of 4 billion board feet of timber. This includes a calculated loss of increment, approximately 140 board feet per acre per year, due to taking the timberland out of production. It does not include the millions of board feet salvaged during the period. Slightly more than 3 billion feet of this loss occurred after the unit was placed under protection in 1905. Figure 3 shows the timber volume losses due to destructive fires.

The volume logged since 1905 totals 5.2 billion board feet (fig. 3), including the volume of burned timber that was salvaged. About

299,000 acres of the original timbered area of the unit has been cut over (fig. 1).

The original volume of timber on the unit is estimated at 22.4 billion board feet. Volume lost as a result of destructive fires is 4 billion board feet and the volume removed through logging totals 5.2 billion board feet. The estimated volume remaining on the unit at the end of 1948 is 13.2 billion board feet of which about 10 billion board feet is classed as commercial.

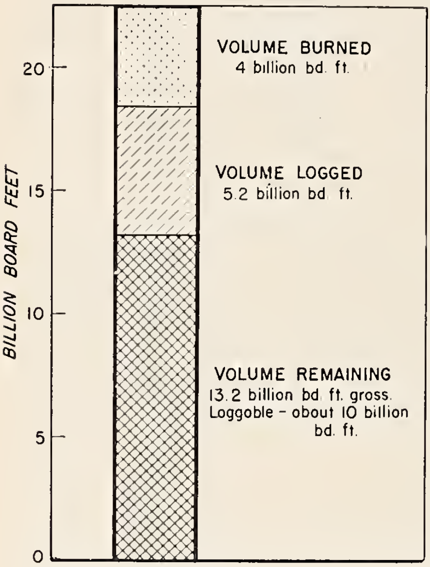


FIGURE 3.—Reduction in total original volume of timber due to fire and logging.

The figures on volume reduction reveal that 43 percent has been due to fires. In other words, the loss of timber by destructive fires has almost kept pace with the volume taken out through logging. Another way of emphasizing the severity of fires is to state that the potential pay roll lost because of fires is almost equal to the total woods and mill pay roll since 1905.

In order to determine the economic value of the total timber loss due to destructive fires, the average price per thousand board feet for timber sold by the management unit in 1948 was used. This figure, $13.16, applied to the volume destroyed, reveals that the present value of timber lost due to previous destructive fires would amount to the staggering sum of $52,640,000.

Most of the destructive timber fires in this area result in the creation of dense brush fields where it is almost impossible for regeneration of trees to take place. The destructive fires usually take the land out of timber production for a great many years, in some cases for more than 100 to 200 years. For that reason, the annual increment loss due to these fires may be directly chargeable to failures in fire protection. This loss is estimated at 29 million board feet annually. The current average stumpage rate of $13.16 per thousand board feet applied to this volume indicates that the owners of the management unit are losing about $381,640 each year because of past failures in fire protection.

This dollar value, which is charged as an annual increment loss, is 2½ times the $150,000 now being spent annually by the owners to protect the unit. The protection price being met by the owners, however, is not the $150,000 actually being spent, but more than $500,000, which includes the monetary value of the annual increment loss due to past failures in protection. Looking at it another way, if successful protection had been accomplished through the years, the value of the annual increment now lost would more than pay the present annual protection bill.

The total loss in loggable timber, calculated at a value of $52,640,000, cannot be overlooked. If the owners had spent such a sum on fire protection and the protection had been successful, they would have at least broken even. It appears defensible, therefore, to say that more than $1,000,000 could have been spent annually for protection on the area. It is certain that this amount is many times the amount that would be needed to provide the degree of fire protection required to assure successful management of the timber resource.

It can be concluded that the failure in protecting this management unit from destructive forest fires has resulted in a real monetary loss to the owners. If they had annually invested a small amount of additional funds in protection, they would have approximately 160,000 acres of timber producing lands that they do not now have. In their present condition these lands will not produce any real timber values for more than a hundred years, unless artificial revegetation (somewhat doubtful in such brush fields) can be accomplished. In addition, the loss of the vast amount of raw material has meant a potential payroll loss of more than $100,000,000, a matter for real concern.

Intangible losses, never measurable, would undoubtedly raise the total loss chargeable to destructive forest fires much higher than that calculated here, probably to somewhere in the neighborhood of $200,000,000.

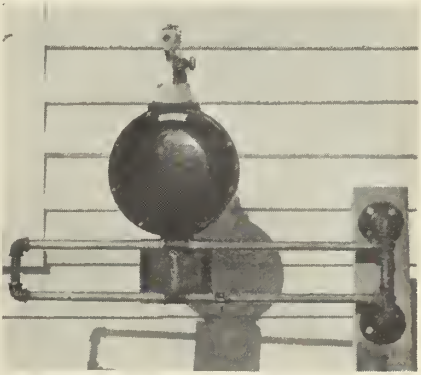
An analysis of losses due to destructive fires in relation to the amounts spent for fire protection might well be made for other timber management areas throughout the Nation. These analyses could provide forceable arguments for more adequate fire protection.

Navy Deck Alidade as a Forest Fire Finder.—The Connecticut Park and Forest Commission has installed in some of its towers a new forest fire finder, which may be of interest to others if the instrument becomes available in quantity at a reasonable price. The Commission purchased 20 of these instruments (Model O, Mark V) from the University of Connecticut's education department for 50 cents each. They were surplus property presumably acquired for training purposes.

This instrument, used by the United States Navy, is called surface lookout alidade or Navy deck alidade. It is a simple device with an azimuth circle that can be read easily and rapidly.

The high-powered finder was replaced by a ½-inch brass sighting tube about a foot long, with cross hair in it. Binoculars can be fastened on the sighting device if desired.

The State has not tested this instrument thoroughly, but several towers will be equipped with them for the 1950 spring fire season. Three have already been installed. One advantage of this finder over the ordinary alidade is it allows more room for the observer, and any visitors, in a 7- by 7-foot cab. It is also possible its use may increase accuracy. A disadvantage may be that it cannot to moved to avoid sighting into the four corner posts of the cab.—Ed Ritter, *Forester, Region 7, U. S. Forest Service.*



Navy deck alidade, with brass sighting tube. Azimuth is read at white strip.

STREAM FLOW AS A MEANS OF FORECASTING PERIODS OF EXTREME BURNING CONDITIONS

MASON B. BRUCE

Forester, U. S. Forest Service, Washington, D. C.[1]

The White Mountain National Forest, like most of the New England State fire-fighting services, was caught napping during the fall of 1947. Standard fire-danger meters indicated the usual fall build-up of burning conditions which takes place as soon as fall frosts clear the trees of leaves. Although it was realized that general conditions were much drier than usual, no one on the forest foresaw the likelihood of such a catastrophic fire as the Fryeburg-Brownfield fire which made its major run just a few miles from the national forest boundary.

In an attempt to profit by experience, forest personnel spent considerable effort trying to find out how the extreme burning conditions might have been foreseen in time to alert local fire-fighting organizations and establish commensurate prevention and suppression safeguards. Graphs showing day-by-day fire danger as measured by 5–B and 5–W forest-fire-danger meters failed to give any indication of a build-up during the summer months of 1947. Charts showing occurrence of precipitation by days or periods likewise failed to show a trend sufficiently different from ordinary to be a basis for alarm. None of the accepted indicators seemed to give cause for apprehension.[2]

It was recalled that during the summer of 1947 local farmers complained that wells which had produced abundantly for long periods had gone dry during August and September, and the peak water shortage had occurred just about the time the huge fires reached their climax in October. Perhaps there might be a relationship between the sustained occurrence of unusually low ground-water levels and extreme burning conditions.

Unfortunately, the U. S. Geological Survey maintained no ground-water measuring stations in the vicinity of the National Forest. The nearest thing to an indicator of ground-water fluctuations seemed to be departures from normal in stream flow, there being a rather close relationship between stream flow and the supply of available ground water. The Geological Survey advised that it could furnish monthly discharge data for the year 1947 as well as monthly normals for one of the important streams leaving the forest. Current data for the same stream could be made available on the second day of each month for the preceding month.

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[1] Formerly Assistant Supervisor, White Mountain National Forest.

[2] Forest Fire Danger Meters 5–B and 5–W were developed at the Southeastern Forest Experiment Station. Personnel at the station have believed for some time that the meters probably do not indicate as high danger as exists during prolonged periods of dry weather. They have consequently been doing some work with the idea of incorporating a drought factor. Progress to date has not been sufficient to know the value of its inclusion.

Use of the 5–W 100 meter was not begun in Region 7 until the fall of 1947. Consequently, White Mountain National Forest's experience with it in the month of October of that year was extremely limited. Since that time burning indexes for each day in October for the years 1943 to 1947, inclusive, were summed for New Hampshire. By October 21 the cumulated burning index for 1947 was 313 as against 159 in 1945, the next highest year. This would indicate a sharp build-up for that month in 1947.

Under similar conditions of drought, intermittent rains of small amounts should perhaps be ignored and the wind velocity carefully watched. Wind velocity is by far the major factor in fire danger, and an increase during a drought period is indicative of extreme danger.

Using the data provided, plus and minus departures in stream flow from monthly normals were plotted to a convenient scale. It was found that during 1947 a gradually increasing deficiency in stream flow became apparent in early July, reaching a peak in late October. The minor storms which occurred during late summer had little effect on the trend which showed strikingly on the graph. Here was a measurable trend that originated several months before the extreme burning period. It seemed that the method might furnish a practical, if empirical, means of forecasting conditions that lead to explosive forest-fire situations.

Further checking was needed to determine if similar sustained stream-flow deficiency trends may have occurred at other times in the past and, if so, whether these outstanding deficiencies were accompanied by bad forest-fire situations. Stream-flow data for the preceding 10 years were obtained from the U. S. Geological Survey, and departures from normal flows plotted in the same manner. During the decade prior to 1947 there occurred only one period, the spring of 1941, when stream-flow deficiencies comparable to late summer and fall of 1947 occurred. It was during this same spring of 1941 that the disastrous Stoddard-Marlow fire of some 25,000 acres occurred in west-central New Hampshire. Burning conditions were known to be extreme at that time and control was obtained with a change in weather. The other less extreme but relatively severe fire periods which had occurred in New Hampshire during the years studied tied in closely with measurable but less striking trends in stream-flow deficiency.

This coordination of events tended to confirm the original findings. The graph in a somewhat similar form has been kept current since 1947 as a means of forecasting the possibility of unusually extreme forest-fire situations. In no way does it replace the standard fire-danger meter for current fire-weather conditions.

WET WATER FOR PRETREATING LITTER FUELS

Wallace L. Fons and Robert S. McBride

California Forest and Range Experiment Station

Forest fire fighters often use water to wet the unburned material bordering the fire line or to sprinkle the area adjacent to a backfire line as a safety measure to reduce spot fires and flaring across the line. The question has been raised as to how the application of wet water would influence the length of time this precautionary measure is effective.

To answer this question an experiment was conducted at Pilgrim Creek on the Shasta National Forest. Two types of forest fuels were studied: ponderosa and lodgepole pine needles, and ponderosa pine twigs ¼-inch in diameter and 4 inches long, with bark intact. The material (four samples of each) was loosely packed in wire screen baskets, 1 foot square and 2 inches deep. The samples were weighed and set out at 8:30 a. m. on a bed of pine needles fully exposed to sun and wind. At noon they were again weighed, and two samples of each fuel type were treated with water and two of each with wet water. The liquids were applied in the form of a fine spray until the samples were saturated.

After the wetting treatment, the samples were weighed periodically throughout the afternoon to determine the moisture losses by evaporation. To represent conditions of a typical fire day, a hot dry day was purposely selected for the study. Average temperature during the afternoon was 90° F., average humidity 17 percent, and wind velocity 4 miles per hour.

For ponderosa and lodgepole needles the evaporation loss during the first 20 minutes was greater with wet water than with plain water. After 20 minutes, however, there was a reversal and the greatest loss occurred from needles treated with plain water. This occurs because at first the wet water spreads over a greater area on the needles and thus exposes a large surface to evaporation. Conversely, the plain water does not spread readily but remains in droplet form, so that a smaller total area is exposed to evaporation. After a short period, however, the excess wet water evaporates; the remainder, which penetrates into the needles, is held tenaciously, reducing the rate of evaporation. Plain water does not readily penetrate the needles but remains on the surface and is evaporated.

For the twigs, though, this 20-minute reversal is not apparent. Twigs treated with wet water retained the most moisture in the first weighing. It is probable that both plain and wet water penetrate the porous bark of the twigs and evaporation is not solely a surface phenomenon. The wet water penetrates deeper and becomes more inaccessible to evaporation.

How may this information be applied to problems in the field? What does it mean to a man setting a backfire? Sixty minutes after spraying with wet water ponderosa pine needles had a 17.5 percent moisture content; those moistened with water alone had 12.5 percent. Let us assume a hypothetical case with wind of 10 m. p. h., slope of 30 percent, and temperature of 81°–90° F. Under these conditions the Region 5 fire danger indexes for moisture contents of 17.5 and 12.5 percent are 25 and 16. Therefore, we can say that the application of wet water instead of plain water, after 60 minutes, gives an advantage of 1½ in reducing the spread of fire.

Another way to look at the situation is this: We might suppose that a fire boss wants to backfire an area. He wets the adjacent material. However, he does not burn it immediately because of some unforeseen problem. How long will the wetting be effective, supposing that 12.5 percent is the critical moisture content? Water allows him 60 minutes to do the burning; with wet water he has 95 minutes before the moisture content reaches 12.5 percent. The use of wet water would give him an advantage of half an hour.

Aircraft Use, 1949.—Aircraft during 1949, in connection with fire operations by the U. S. Forest Service, made 7,957 flights for a total of 10,548 hours of flying. They transported 8,770 men and 1,318,000 pounds of cargo.

Tractor Dozer Use, 1949.—During 1949 tractor dozers were used on 287 fires fought by the U. S. Forest Service. Work accomplished involved construction of 22,339 chains of held fire line, 10,942 chains of safety and lost line, and 14,363 chains of "ways" prepared for the ingress and egress of transportation equipment, a total of 47,644 chains, or 895 miles, of fire line and "ways."

Tanker Use, 1949.—The U. S. Forest Service reports that out of a total of approximately 11,000 fires occurring on national-forest protection areas during 1949, tank trucks were used on 2,382 fires or about 22 percent of the total. They were used as the primary means of initial attack on 1,281 fires and of this number assured control of 1,001.

TESTS SHOW CIGAR AND CIGARETTE STUBS COME DOWN HOT

H. T. Gisborne[1]

Ever since airplanes began flying over the forests there have been lively discussions as to whether or not burning smoking materials thrown from an airplane might start fires. Recently, Mr. C. M. Johnson, assistant director of Keep Washington Green, Inc., asked us the direct question: "Can lighted material (meaning smokes) thrown from a plane ignite forest materials?"

We had some facts, based on tests that Bevier Show and I made back in 1922, plus at least 100 trials I have made since then. Those tests showed that all sources of heat as large and as hot as the coal that breaks off a hand-rolled cigarette would ignite dry, rotten wood.

We also had enough cases to justify the opinion that on loose duff or crushed-down dead grass, a hot pipe heel was most dangerous, a hand-rolled cigarette second, and a "tailor-made" third. No tests with cigars were made.

The reason for the above order of danger lies in the fact that a pipe heel or coal from a hand-rolled, which usually breaks off, is likely to filter down into the duff or grass where it touches more pieces of fuel and where more of its rising heat is effective in warming material above it. The "tailor-made," by contrast, more frequently comes to rest on top the duff or grass, touching only two or three pieces of fuel. Most of its heat therefore rises up into the air where it dissipates quickly.

Even with oven-dry duff and grass, Show and I got very few ignitions from any source unless we turned a fan directly on the spot. And that, by the way, was the method used by the Bureau of Standards in their tests some 20 years ago. However, as the wind velocity at the grass roots or the duff surface under a tree or brush canopy is seldom more than 2 or 3 miles per hour, we did not assume that much wind should be considered as normal. Under abnormal conditions almost anything can happen, of course.[2]

Hence, we had some basis for an opinion on the relative dangers of pipe heels and cigarette stubs on rotten wood, duff, and grass. We had no facts, however, as to what would happen to any hot smoking materials thrown from an airplane. So on October 26 Fred Stillings rounded up enough smoke jumpers to corral a fair-sized fire, and with 3 men in the plane to do the smoking, and 6 or 8 of us on the ground to see what came down, we made some tests at Hale Field in Missoula. A dozen halves of 5-cent cigars and 40 good cigarettes were lighted and thrown from the plane.

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[1] H. T. Gisborne, Chief, Division of Fire Research, Northern Rocky Mountain Forest and Range Experiment Station, died November 9, 1949, while making a study of the Mann Gulch fire on the Helena National Forest, Mont., in which 13 men lost their lives on August 5.

Mr. Gisborne was internationally known for his pioneering work in measuring and rating weather factors which influence the behavior of forest fires. He developed the system of measuring humidity, fuel moisture, precipitation, and wind velocity which can be translated into numerical terms of fire danger, known as the forest fire danger meter. He designed weather instruments now widely used on forest fire weather stations.

In November 1947, Secretary of Agriculture Clinton P. Anderson personally presented Mr. Gisborne with a silver medal emblematic of superior service to the Government, in recognition of his great achievements during the past 25 years in forest fire control research.

[2] Nothing in this report can be interpreted to minimize the danger of forest fires from people smoking in the woods, either on foot, horse, or driving through them. Millions of cigarettes are smoked and flipped by such people. Even if the chances are 500 to 1 against ignition, careless smoking can and does cause thousands of fires each year.

With the plane flying at about 120 miles per hour and 500 feet above ground, we could see both the half cigars and the full cigarettes coming down; but when the stubs were thrown out at 1,000 and 2,000 feet, that was very difficult. Furthermore, the condition of 2 of the cigars recovered indicated that either the impact of the 120-mile wind or a hard bump against the fuselage or tail surface of the plane may have torn some of the stubs into small bits. We recovered only 3 of the 12 half cigars and only 25 of the 40 cigarettes thrown out. Of these, all 3 cigar stubs were hot enough to burn holes through the paper toweling on which we tried to catch them. Twenty of the 25 cigarettes recovered, or 80 percent, were likewise hot when caught or picked up.

The condition of some of the hot cigarettes was perhaps significant. The tobacco was burning back inside the tube of paper, which itself was not even scorched on the outside. This may have been due to the cool temperature and moderately high humidity of the hour when we made the tests. It may be, too, that the cooling of the paper surface even when falling through hot, dry air is sufficient to keep the paper from heating to the ignition temperature. Whether or not this adds to the ignition danger is anybody's guess. It seems evident, nevertheless, that the hot coal being inside the paper tube is thereby prevented from breaking off on landing, and then falling down into the duff or grass where its heat is most effective.

Our pilots pointed out one other significant fact, to wit: Even if the plane has a door or window which can be opened, it is not only difficult to open the door against the slip stream but it is dangerous to the plane. Most pilots will be quick to realize that the hot ember may be blown back into the plane or may lodge in a point in the tail assembly and cause damage. The chance of the ember being blown back into the plane was demonstrated in our tests by Floyd Bowman's pants. His wife had to darn four or five holes burned in them.

From these few preliminary tests the answer to Mr. Johnson's question appears to be: Yes, lighted material thrown from a plane can ignite forest materials. But the chances are very small if the ember lands on any material except dry, rotten wood.

MECHANICAL FIRE HAZARD REDUCER

Ed Ritter

Forester, Region 7, U. S. Forest Service

A firm at Fitchburg, Mass., has manufactured and put on the market a portable wood chipper which has created considerable interest in the Northeast. Some of the models may be mounted on light trailers although others are built for mounting on trucks so that "progressive" chipping might be made easier. Cutting blades are of five sizes: 5, 6, 9, 11, and 14 inches. The one I observed was being tried out by the Connecticut Park and Forest Commission. It had a 6-inch blade, was mounted on a light trailer, and was powered by a Wisconsin air-cooled, four-cycle, V–4 motor. I was told by a representative of the company that this machine retails for $1,970.

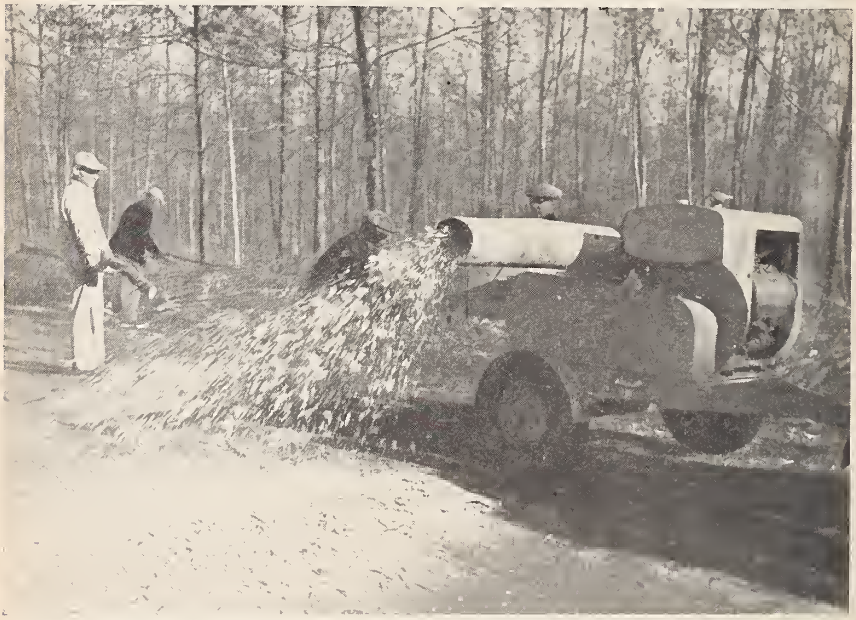

Figure 1.—Portable wood chipper in use. Chips may be blown 15 or more feet from machine to remove debris from roadway or direct into a truck for carting away.

Wood chips might be used for a variety of purposes, such as mulch for strawberry plants, bedding in dairy barns, poultry and hogpens, and as a source of compost material. Highway crews could make use of a chipper in disposing of brush along rights-of-way. Recreational maintenance crews might use chips in stabilizing slopes and sandy light soils when heavy use tends to churn up the ground. However, my principal interest in a chipper lies in its ability to dispose of brush as a fire-hazard reduction measure.

Ordinarily, there is little need to burn or otherwise dispose of the usual accumulation of hardwood brush. Coniferous material is more hazardous and is often burned during safe seasons. The 6-inch chipper observed in operation literally "eats up" soft or hardwood brush and slash up to 4 inches in diameter. Chips may be blown into a truck and hauled away or scattered along the roadside as the operator chooses.

My observations have not been sufficient to determine what the cost might be as compared to piling and burning or other means of brush disposal. But considering the soil-building possibilities and various other uses of wood chips, the net cost chargeable to fire-hazard reduction might be fairly reasonable.

Corrosion of Metals by Wet Water.—One of the problems encountered in using wetting agents is increased corrosion in fire-fighting equipment. An experiment conducted at the California Forest and Range Experiment Station shows that a readily available chemical can be used to reduce corrosion.

The test was made to determine the corrosive action of wetting agents upon 24-gage iron and galvanized iron. These metals were selected because they are used in construction of tanks for back-pack pumps and for some fire trucks. Strips of the metals (½ by 4 inches) were cleaned, weighed, and immersed in test tubes containing wet water solutions. Potassium dichromate, a known inhibitor of corrosion which does not affect wetting properties, was added to four test tubes, two with water and two with an agent. Each received 300 parts per million of potassium dichromate (about 0.04 ounce per gallon). At the end of one month the strips were removed from the solutions, cleaned, and weighed to determine corrosion losses.

Tests with iron and 13 wetting agents revealed that 6 of the agents had higher corrosion losses than plain water. Some of these agents may contain inhibitors; one that is known to contain a dichromate salt had a corrosion rate lower than water. Adding potassium dichromate to plain water reduced its corrosion rate on iron by 10 times. This inhibitor reduced corrosion of one of the tested wetting agents by about 10 percent.

Tests with galvanized iron revealed that all but 3 of the 13 wetting agents had higher corrosion rates than plain water. Potassium dichromate was very effective in reducing the corrosion rate on galvanized iron. The agent known to contain a dichromate salt had a corrosion rate three-fifths of that for water alone. Adding potassium dichromate to plain water reduced its corrosion rate on galvanized iron by 5 times. Most important, this inhibitor reduced corrosion of one of the tested wetting agents from twice that for plain water to two-fifths that for water.

In general, it was found that galvanized iron is more readily corroded by wetting agents than is the iron. The zinc coating probably reacts more easily with the chemicals in the wet water solutions.

The test indicates that corrosion rates increase with increase in acidity of the solutions. Adding potassium dichromate to plain water or to a wetting agent solution increases their acidity; but due to the formation of a protective coating by the dichromate, corrosion is decreased. One precaution must be observed when using potassium dichromate—it is a poison, and water treated with it should not be used for human consumption.—ROBERT S. MCBRIDE, *California Forest and Range Experiment Station.*

HELICOPTERS AND RADIOS ON THE STANISLAUS NATIONAL FOREST

Allen F. Miller

Forest Supervisor, Stanislaus National Forest

The effective use of helicopters can be greatly increased by close coordination with radio. This was demonstrated on the Walton Spur fire on the Stanislaus National Forest during August 1949. The equipment used was a Bell two-place (pilot and passenger) helicopter, and KUT2-KUR, UT-UR and SX-type radio.

The fire burned in the steep inaccessible Tuolumne River Canyon at the mouth of the Clavey River. Elevations on the fire ranged from 1,200 to 3,500 feet. Jawbone Ridge, a steep narrow divide between the Clavey River and the main Tuolumne River, was inaccessible except by foot travel through heavy brush.

It was possible to get to the top edge of the canyons by road, but travel into and out of the steep rugged canyons was by foot. This foot travel was slow and dangerous. The fire was handled in two parts because of the inaccessible canyon, but the radio communication enabled one helicopter to service both parts.

Both the Clavey and the Tuolumne Rivers were low at the time of the fire and numerous sand bars were exposed. These sand bars were later used as landing spots for the helicopter. Landing spots were also prepared around the perimeter of the fire and on Jawbone Ridge. Once these landing spots were developed, movement of men became quick and effective. Travel by helicopter from Walton Spur spot No. 1 to Groveland spot No. 2 required 10 minutes. The same trip by car required 2½ hours. Five men were moved in five trips from Walton Spur spot No. 1 to Jawbone Ridge spot No. 3 in 38 minutes. Travel by car and foot would have required 2½ hours. The last 2 miles on foot would have been through steep brush country. By using the helicopter, the men were fresh upon arrival on the fire. On another occasion, 22 men were moved in 72 minutes to Jawbone Ridge. It required slightly over 3 minutes for a round trip. Each man carried his own fire-fighting tool and when he arrived on Jawbone Ridge, he was fresh and ready to work. He only had to walk a short distance to the fire line and went to work immediately. The first man was on the fire in 3 minutes and the crew was built up rapidly. The travel time by truck and foot would have required more than 2 hours.

All direction of the helicopter was by radio. KUT2-KUR sets were placed at all operating landing spots near the fire camps and SX sets were used on the isolated spots. One UT-UR type was used in the Bull Meadow fire camp A. The helicopter was not equipped with radio. The first man to land on an isolated spot carried a radio, and communication was immediately established with his home base. This proved very useful as it was possible to determine the needs of the crews and to return the crews when necessary. It avoided long delays or unnecessary trips by the helicopter to contact these isolated landing spots to determine needs.

By having radio communication between the landing spots, the helicopter was shuttled between spots to accomplish needed missions and there was very little stand-by time. The helicopter was on the fire 6 days and there was a possible flying time of 63 hours and 53 minutes. It actually flew 44 hours and 5 minutes or 69 percent of the time. There were only 3 hours and 7 minutes of stand-by time. The rest of the time was spent refueling and repairing the helicopter and feeding and resting the pilot.

The helicopter-radio combination was used very effectively in removing a badly burned man from the fire line. The accident occurred about midway up the steep canyon slope. An SX radio was

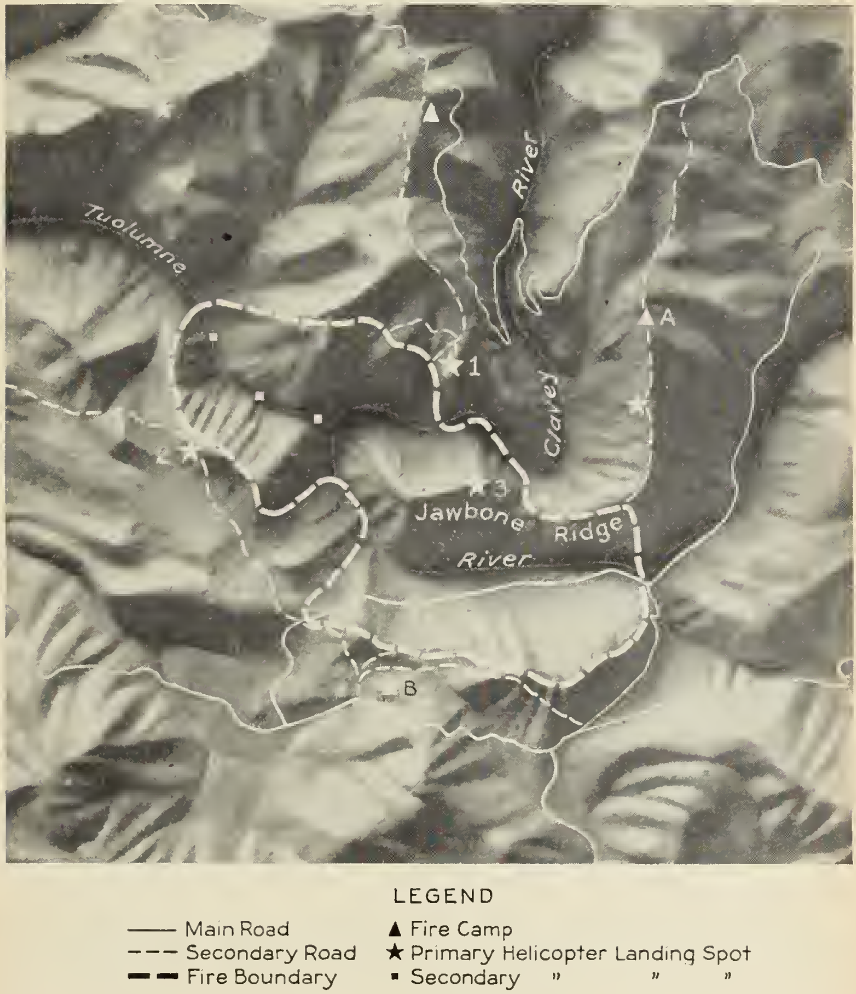

FIGURE 1.—Walton Spur Fire on the Stanislaus National Forest, August 1949.

sent to the crew aiding the injured man. They decided to move the man down to the river to a sand bar and have the helicopter transport him to the hospital at Sonora. They radioed that they needed a stretcher. One was dropped to them by the helicopter. The progress of the crew was reported by radio to the Groveland fire camp B as they made their way toward the river. Steep rocky bluffs near the river stopped their progress until 300 feet of rope could be dropped to them. When they reached the river, the helicopter was waiting for them and the injured man was immediately transported to the landing spot near Groveland. The doctor had advised against transporting the injured man to Sonora by helicopter because of the danger from shock.

Late on the fifth day of the fire it was decided to burn out along the Clavey River on the Jawbone Ridge side. Men were flown to a sand bar in the Clavey River and stationed along the river bank. Then lighted fusees were dropped from the helicopter and completed the burn-out. Of 17 fusees dropped, 15 set backfires. One landed on a rocky ledge and the other was snuffed out by the fall.

A planned system of landing spots located on strategic points throughout the forest would greatly increase the early effectiveness of the helicopter. These spots should also be radio-checked with the forest radio net, and all other things being equal, selected on the basis of their radio suitability. A radio set in the helicopter would be desirable, but not essential.

With careful correlation between helicopter and radio, the effectiveness of both these tools in fire control can be greatly increased.

INDIVIDUAL SUBSTATIONS FOR MAIN OFFICE RADIO

CHESTER E. LYONS

Engineering Aide, Communications, Deschutes National Forest

After our initial installation of FM radio on the Deschutes National Forest, Bend, Oreg., we soon became aware that a remote unit for the administrative assistant and one for the fire assistant did not provide good communications. Often they were left unattended or turned so low that calls were missed. Nearly as bad were the work interruptions as people leaned over the desks to use the sets. We use radio the year around to contact two of our ranger stations, and our

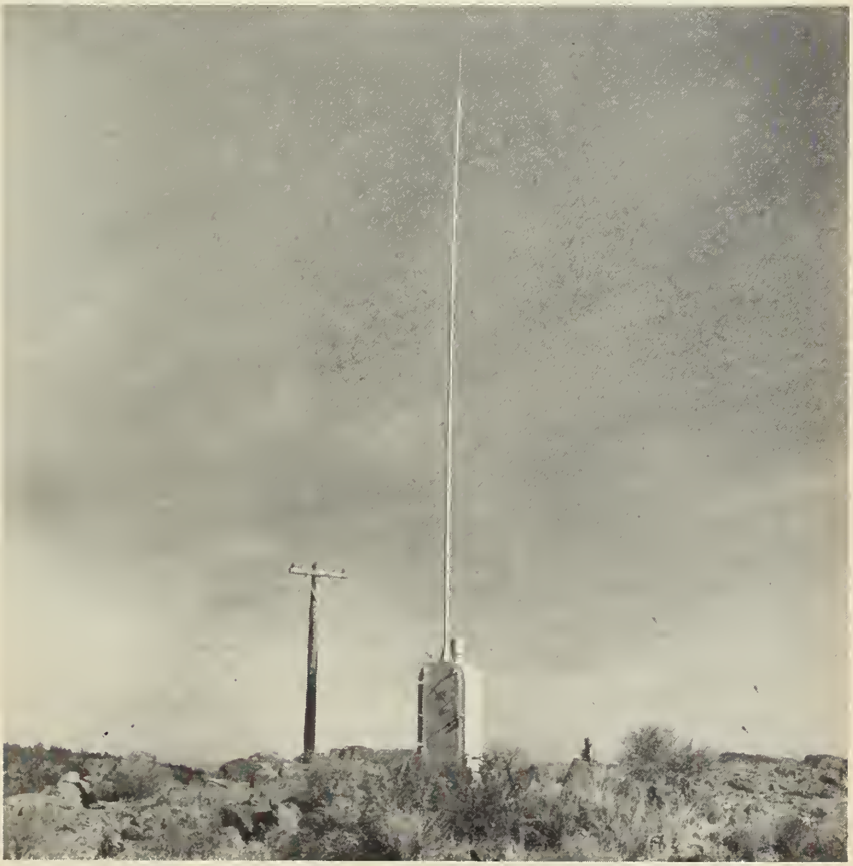

FIGURE 1.—The remote unit set-up is bolted to a concrete slab; the ship doors are bulletproof.

timber-sales program is quite active. With radios on nearly all lookouts and a fair-sized fleet of mobile radios and portable sets, the unceasing "yammer" from the two remotes became a real problem.

We solved the problem by putting one of the remote units on the receptionist's desk, and from this point wired substation sets to the supervisor, administrative assistant, fire assistant, and the timber management, clerk, and engineering personnel. Each of these substations was provided with a buzzer signaling circuit. The second remote unit was not used.

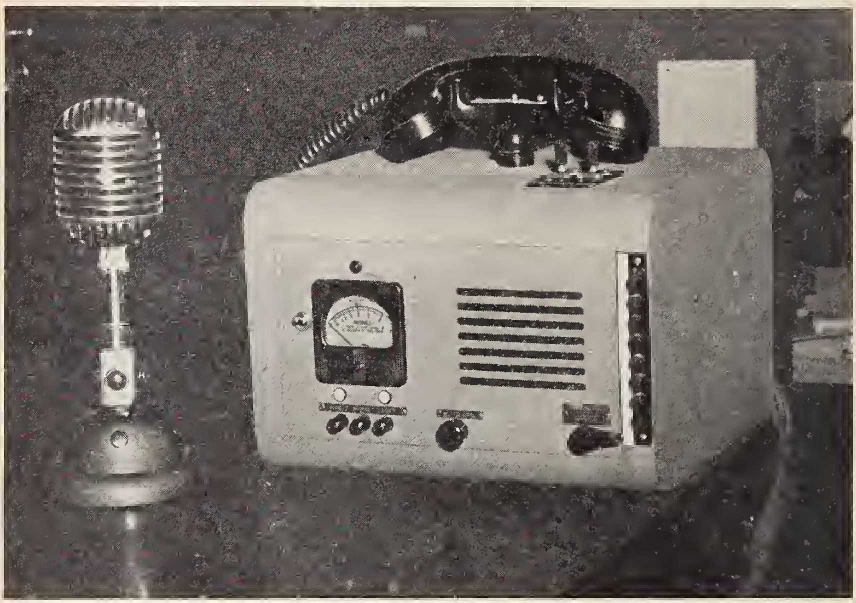

FIGURE 2.—The remote unit; buzzer system buttons on right of panel; risers have been added to handset cradle so push-to-talk switch will clear.

Briefly, our set-up consists of a 50-watt Motorola transmitter that, with the receiver, is housed in a steel box located some 3 miles out of town on a rocky knoll (fig. 1). A 500-ohm telephone line connects the main office remote unit with the set. Another remote unit is wired in parallel across the 500-ohm line to the ranger's office in another building.

The development of the substations was shelved, twice. At first it was discarded as impractical—too many unshielded leads in conduit under the floor, prohibitive cost, and plain unorthodox practice. We picked up the idea again, only to be stopped cold by the cost of commercial push-to-talk handsets. Finally, we acquired several condemned EE–8–A Signal Corps telephones and with the handsets from these phones set to work. It was found necessary to install Western Electric F1 transmitter units in the handsets to achieve maximum, uniform output. Some handsets are already so equipped. The receiver units were found to be comparable to commercial products.

In figure 2 the buttons for the buzzer signaling circuit are on the right front of the panel of the remote unit, two switchboard keys have been installed on top of the unit, and a handset rests in its cradle, also located on top. Figures 3 and 4 show the location and size of the piece of equipment needed to connect the substations to the remote unit. Figure 5 shows a substation fastened to a desk. Both the box and switch hook are used pieces of telephone gear. The new nonkinking cord on the handset was used, as the old original cord was much too long.

Disregarding the wiring for the signaling circuit, three wires are used to connect the substations to the remote unit. The substations are wired in parallel across these three common wires. Probably the most surprising thing about the substation circuits is the fact that no further provision of current is needed to drive the F1 units in the handsets.

The dynamic microphone in figure 6 is normally connected with the "hot side" of the microphone going directly to the grid. The switch on the microphone completes the circuit to ground, closing the relay. Current to energize the microphone comes through a resister in the grid circuit. This explains why the switch Sw 1 is needed. It is a switch to take the dynamic microphone out of the circuit. Without this switch the microphone would be "hot" whenever the relay in the remote unit was closed by a substation handset, picking up random noises, typewriter clicks, and conversation. However, through this same circuit the current for the substations is provided.

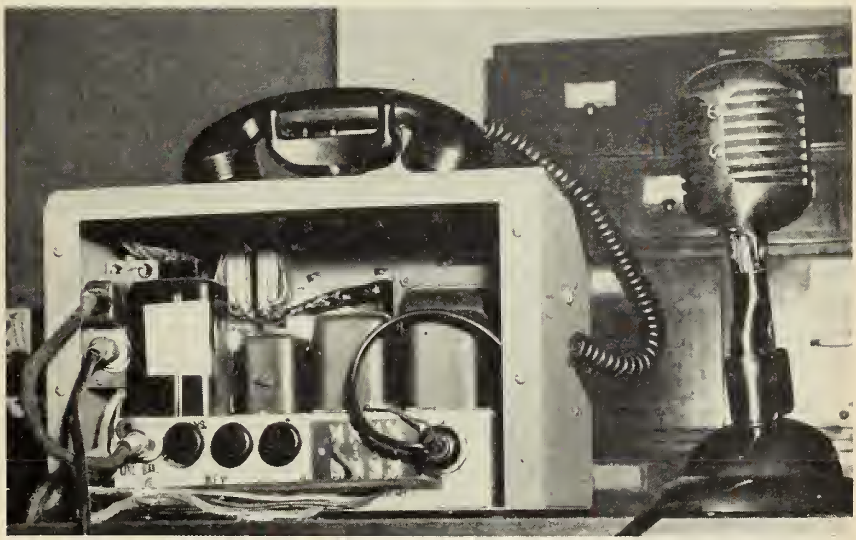

FIGURE 3.—Rear of remote unit with plate removed. Microphone cable goes to added unit. Interunit cable connects added unit to remote unit. Note on relay cover reads, "The only actual change in this remote unit is the removal of a jumper in the Xtal mike plug from # 3 and # 4."

The speaker switch Sw 2 acts as an additional mute circuit. Closing this switch cuts off the speaker, and the signal is heard in the handset even though it is resting in the cradle. The signal heard in this manner is much the same as with any telephone off the hook. It provides ample volume for standby without filling the room full of sound. The addition of the handset to the remote unit also gives the receptionist a choice of operation. During times when her room has visitors, it allows her to carry on radio conversation as unobstrusively as answering the telephone. For her normal dispatch of traffic, however, she has found the dynamic microphone to be more convenient. The cradle for the operator's handset is wired so that the speaker is cut off and the signal is heard in the handset in the "off cradle" position. (The make-and-break action of the cradle must occur as shown when the handset is in the "in cradle" position.) Both the operator's handset and cradle were manufactured commercially.

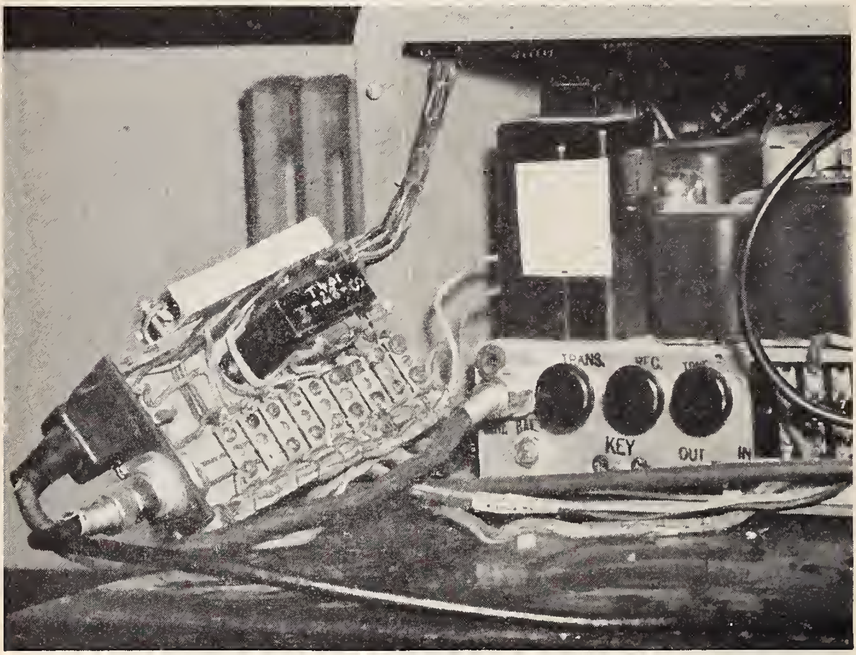

FIGURE 4.—Special unit out for observation. The sidetone condenser is on top. The impedance matching transformer is placed between the condenser and terminal strip.

We rewired the action of the handset as shown and made some revisions in the cradle to get the desired action. However, this handset could have been another EE–8–A handset and mounted in a box. In fact, the microphone and speaker switch, the equipment that connects the remote unit to the substations, could all be installed in some sort of external unit. The interunit wiring is not critical.

The condenser C1, in figure 6 serves the same purpose as the condenser in figure 7. These condensers prevent an accidental DC voltage from spoiling the receivers in the handsets. Condenser C2 however, has an entirely different function. It serves to provide sidetone to the substation system, allowing both sides of a conversation to be heard from any substation handset, thus providing facilities for three-way conversations.

We tried a lot of transformers to properly match impedances, and finally found one among some spare parts with a 1,000-ohm primary and a 35-ohm secondary winding. It matches the external speaker output of the remote unit (terminals 1 and 2) well enough that even with all six of the substations off the hook and in the circuit, no noticeable drop in signal strength is heard. Roughly, this means that twice the number of handsets that we are using could be employed in similar systems. The U. S. Forest Service Radio Laboratory in Portland, Oreg., has the complete data on this transformer.

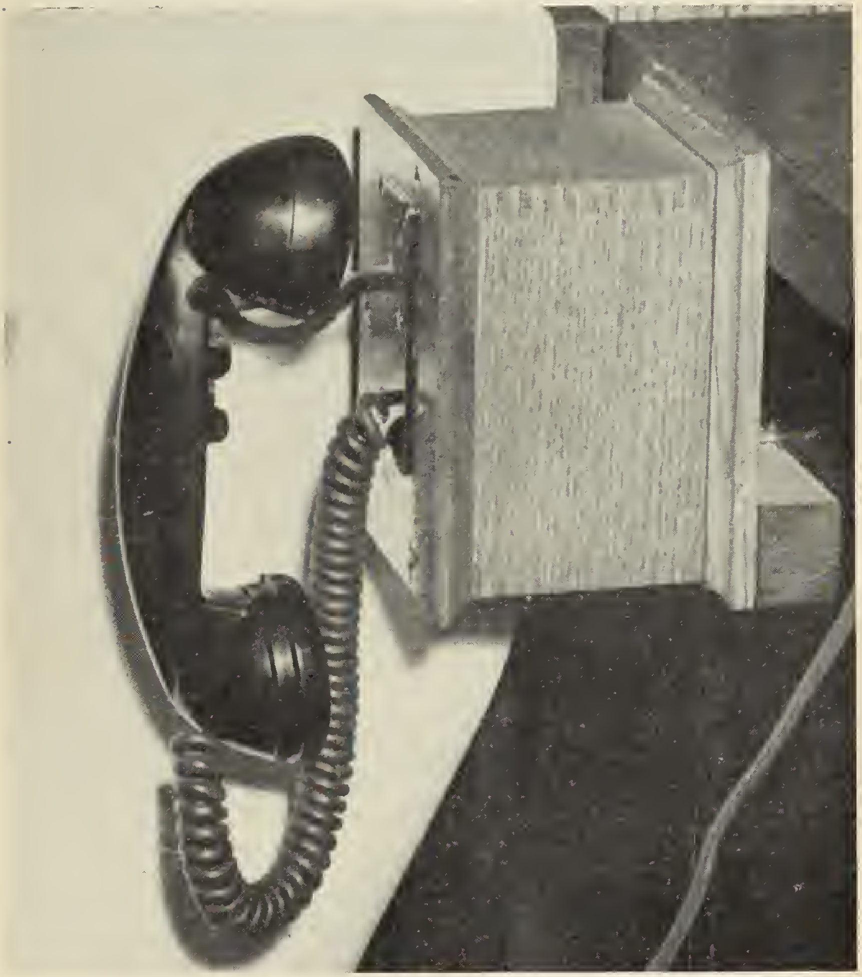

FIGURE 5.—One of the substations. Old ringer boxes, made of durable hardwood, are fine for size. The condenser, hook-switch, and wiring are inside.

Figure 8 shows a remote unit and two substations complete with buzzer signaling circuit. Note that eight wires are needed to completely connect these three positions. For each additional position, another wire must be added to the signaling circuit. We have four

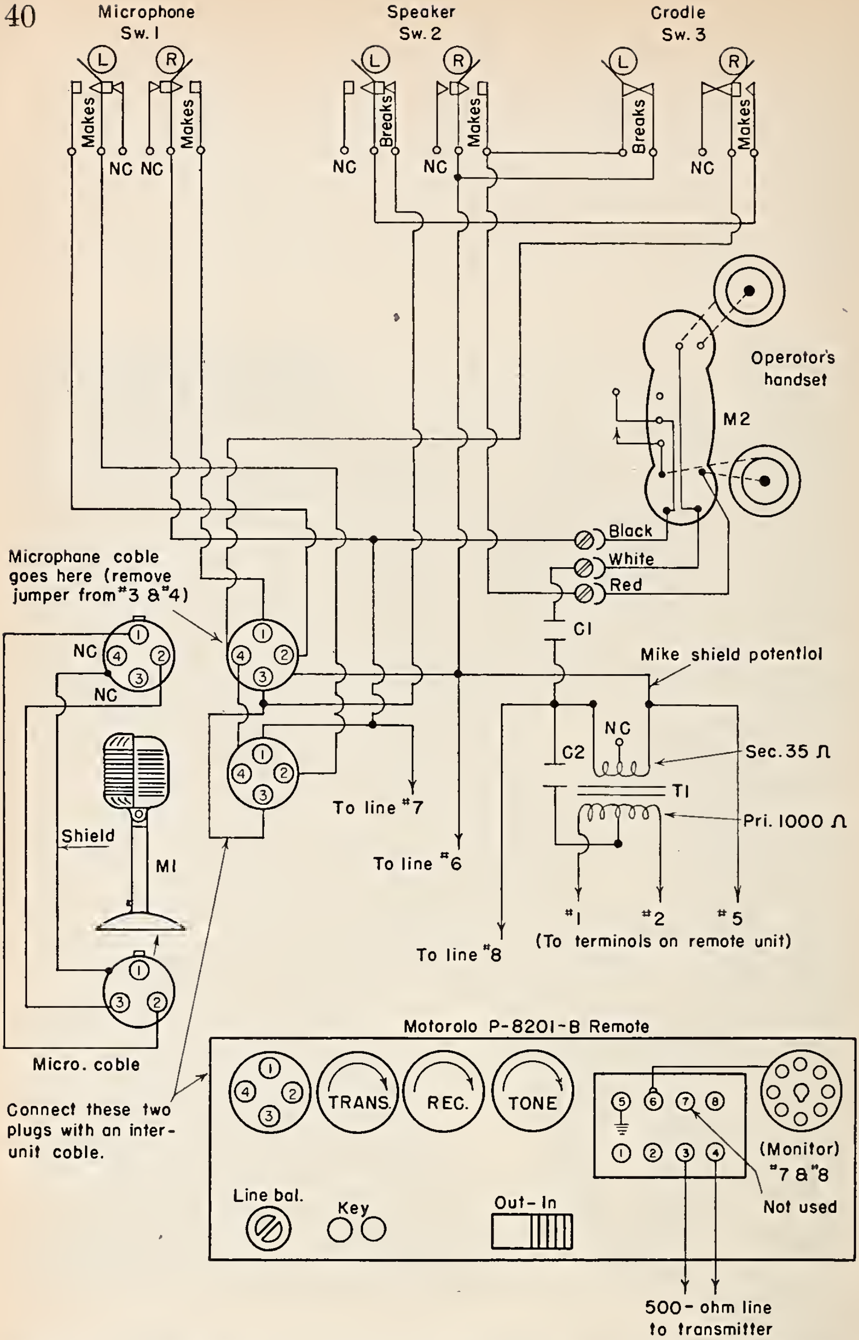

FIGURE 6.—Operator's circuit. Some of the parts are: Sw 1 and Sw 2, key, switchboard "Kellogg" No. 1028; Sw 3, cradle, telephone handset "Monophone" (revised); M1, Model 55 microphone, crystal dynamic "Unidyne" (furnished with remote unit); M2, handset, telephone push-to-talk "Monophone" (revised); C1 and C2, condensers, Western Electric No. 149E 1 mfd.; T1, audio transformer, No. S-27-X (any small transformer with approximately 1,000-ohm primary winding, center tapped, and a 35-ohm secondary winding). Also needed are two female and two male microphone receptacles to make up the interunit cable.

more substations than shown in this diagram; consequently, we use twelve wires in conduit under the floor. The system picks up just enough hum for one to be aware of it when our carrier is unmodulated. It is no more than that and is definitely no trouble.

This system can be hooked up experimentally by any technician using parts from his stock. The wiring of the remote unit is left completely undisturbed. The only actual change that is made to the remote unit is the removal of a jumper wire from terminals 3 and 4 in the microphone plug. The method of adjusting the "Trans" control knob is a little different, due possibly to the condenser C2.

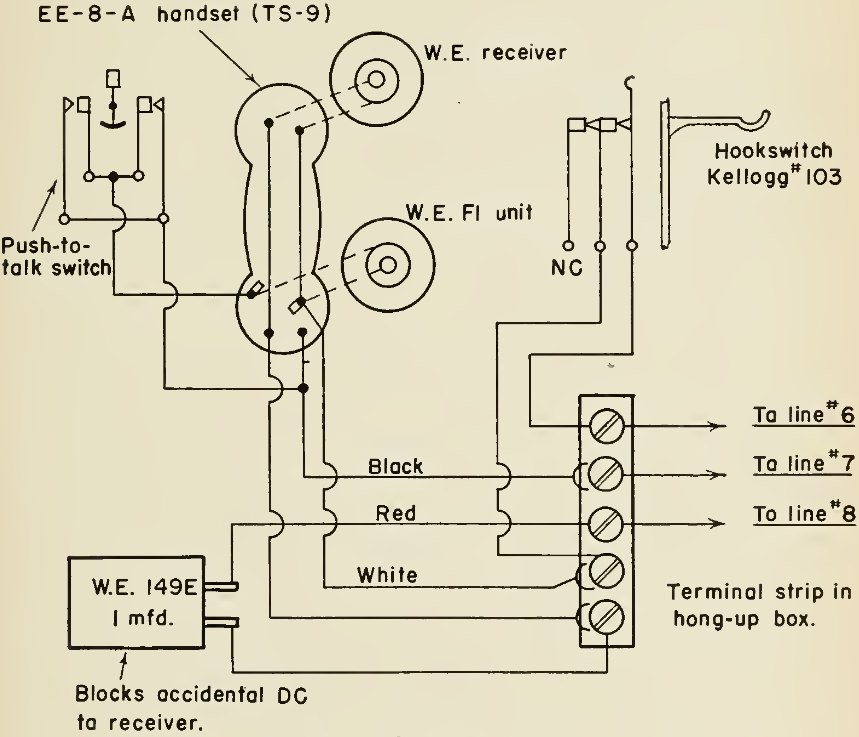

FIGURE 7.—Substation circuit.

Oscillation occurs if the "Trans" knob is advanced too far causing the DB meter to swing off scale and the outgoing signal to be blurred. With the dynamic microphone switched out of the circuit, close the relay in the remote unit by pushing the push-to-talk switch on any of the substation sets or by the push-to-talk switch on the operator's handset. Observing the DB meter, adjust the "Trans" control (handset unmodulated) so that the needle on the meter rests in its normal left-hand position, in other words, so that the needle is quiet. This setting may be found to be too much for the dynamic microphone. If this happens, have the operator speak in such a way as to average zero DB on the meter. It will be about right for the F1 units in the handsets as these will vary with loud and soft voices, distance from the mouthpiece, etc. Adjust the receiver signal at the remote unit as desired. Adjustments here will not vary the handset signal enough to be noticeable.

The actual cash outlay for parts to complete our whole substation system came to less than 10 dollars. The buzzer system had been installed years before. We rewired it (as shown in fig. 8) in order to use less wires than had been used originally. If substations of this type are contemplated and all parts and boxes must be purchased, the cost per substation will run about 8 dollars. The saving will be appreciable if the cost of a like commercial product is considered. We could find nothing similar for less than 35 dollars each.

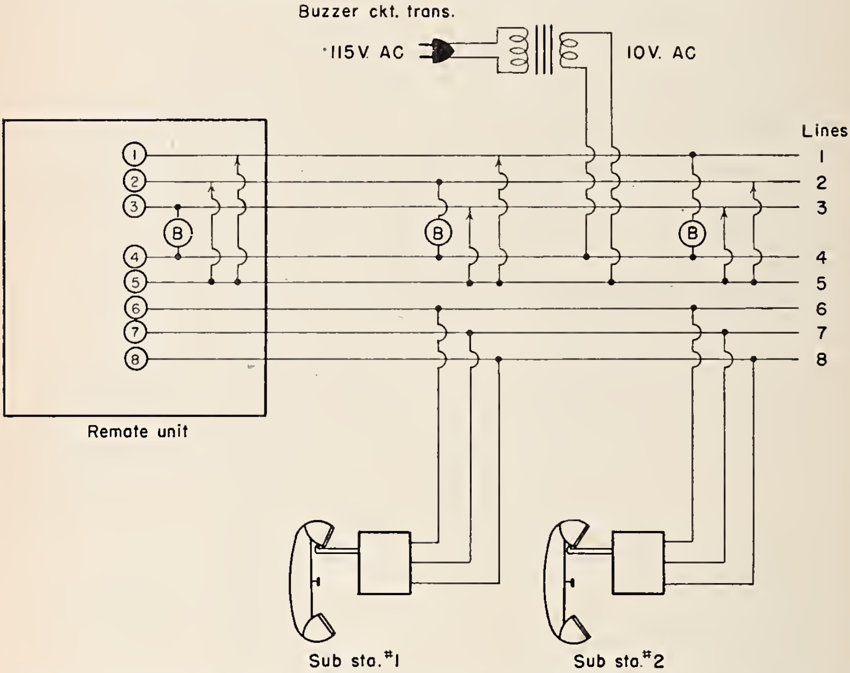

Figure 8.—Remote unit and two substations complete with buzzer signaling circuit. The buzzer circuit transformer is an ordinary doorbell transformer.

The buzzer signaling system buttons and buzzers can be obtained almost anywhere. With the exception of the buttons installed on the remote unit (done this way for the receptionist's convenience) our buttons are in little block affairs that go nicely in a drawer. The buzzers are fastened under the desk.

Our substation setup is only one of many variations that are possible. A similar system can be devised to control almost any type of gear.

Further information on this installation may be obtained by writing the author on the Deschutes National Forest, Bend, Oreg. Also, we are interested in hearing from any forest that makes such an installation.

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It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 11 Number 3

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The printing of this publication has been approved by the Director of the Bureau of the Budget (May 17, 1948).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1950

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HISTORY OF SMOKE JUMPING, 1939–49[1]

Division of Fire Control

U. S. Forest Service, Washington, D. C.

"Elapsed time" is the essence of good fire control. Study of time records of forest fires has shown that travel time, that part of elapsed time from report of the fire until attack is made, is a major factor affecting the final area of a fire. The final area of many a fire has given rise to the wish "If one man could only have got there early enough!"

Forest officers have given much thought to the problem of reducing the travel time to inaccessible or back country fires. As early as 1931 T. V. Pearson, United States Forest Service employee now retired, thought of using airplanes and parachutes to overcome this time handicap. However, it was felt that the time was not ripe to experiment with this novel idea. Parachuting in those days was not considered as something to be planned, but rather as a "last chance" to be used by a man in an airplane just before a crash.

The idea of using airplanes and parachutes to overcome the elapsed-time handicaps was almost "still born." Nothing was done to keep it alive until 1939 when David P. Godwin, then Assistant Chief, Division of Fire Control, took up the idea. Quoting from his article in the April 1940 issue of the Aero Digest: "Since the beginnings of systematic forest fire control, about 30 years ago, men have bent their thoughts and energies toward the extension of forest ways and to faster means of traveling over them. In our National Forests a vast network of transportation routes is now maintained. Along those forest ways, by foot, by horse and by motor, go the men dispatched to suppress fires. On the 23,000 miles of roads, and 137,000 miles of trails, there are 20,000 motor vehicles in use by the Forest Service and more are rented in time of need.

"Gradually the extension of roads and the addition of vehicles are slowing down as the point of diminishing returns approaches. What then? Will current travel-time achievements become static? There will be some continuing extension of ground routes and improvement in ground vehicles, but the results of this in further reduction of travel time will become comparatively unimportant.

"On the other hand, if we can intelligently adapt transportation by air to our ends, it may open up an era of time-cutting which our present forest fire organization plans have hardly glimpsed. For some years aircraft have been used in the delivery of fire fighters and fire control overhead from distant centers to nearer centers, and this has been a great advantage in assembling men for large going fires. We have developed 76 landing fields, but this is pitifully scant distribution over the great area of all of the national forests. More can be constructed, but topography will soon limit such extension. Here again, the curve of progress will begin to flatten out, rising again sharply with the advent of a heavy pay load carrying craft capable of hovering, and of vertical descent and ascent. We then may be able to land aircraft in thousands of small clearings, on beaches, bottoms, and ridge tops.

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[1] Condensed from Regional reports.

"So for the present, at least, comes the question 'What can be done to land men without landing planes?' The question is not new. For years fire control men have mused and argued about the possibilities of parachute jumping of individual trained fire fighters near small fires in back country and thus catch 'em early. Is such a travel-time reducing method mechanically practicable, and is the risk to life and limb a responsibility sane forest officers would care to assume?

"Professional parachute stunt jumping has been confined mostly to airports. The Russian and German armies in maneuvers and in actual warfare have made mass jumps of armed men, but always over open, flat, or rolling country. So far as known, however, there have been no premeditated jumps over rough and timbered terrain such as that found in the high back country of our western forests. It looked too fearful from the air. But as often happens, things are not as bad as they look."

These remarks by the late Mr. Godwin are ample evidence that he was among the first to press for the application of parachute jumping to overcome the travel-time headaches of potentially disastrous back country or inaccessible fires. It was through his efforts that experiments in smoke jumping were undertaken by the United States Forest Service in 1939. As far as is known, these were the first experiments designed to determine whether or not delivery of men to inaccessible fires via airplane and parachute was feasible.

Until 1938 all Forest Service flying in the West had been done by army planes or by private contract fliers. In 1938 the Forest Service purchased a Stinson SR–10 fitted out especially for fire control experimental work. This five-place plane was powered with a 450-horsepower P&W Wasp motor. Rear seats and the door on the starboard side were removed and the interior arranged for cargo. This plane was assigned to Region 5 (California) of the Forest Service and used in fire bombing experiments in that area.

Early in 1939 the bombing experiment was transferred to Region 6 (North Pacific Region). David P. Godwin was in charge of the project. He was assisted by Lige Wernstedt representing the regional division of operation and Harold King, Forest Service pilot. During the summer of 1939, the decision was made to abandon the aerial fire bombing project and to devote efforts for the remainder of the fire season, October 5 to November 15, to experimenting in the delivery of fighters to fires via airplane and parachute.

The location selected for the experiment was an airport near the Winthrop Ranger Station, Chelan National Forest, Wash. C. Otto Lindh, Chief of Fire Control, Region 6, had charge of the field work. Other immediate personnel were Beach Gill, collaborator; David P. Godwin, Assistant Chief of Fire Control, W. O.; T. Albert Davies, technician (later project leader, forest officer); Harold C. King, Forest Service engineer pilot; Walter Anderson, fire assistant, Chelan

National Forest; Frank Derry, head parachute rigger and jumper; Chester Derry, jumper. The Eagle Parachute Co. was the successful bidder for a contract to provide parachutes, protective clothing, and the services of professional riggers and jumpers.

After a number of dummy tests, about 60 live jumps were made largely by professional parachute jumpers employed by the contractor. During the concluding days of the experiment several Forest Service employees were allowed to jump into open fields and timbered areas. There were no injuries of consequence. Here on the Chelan a special handle was bolted to the right-hand strut of the plane to enable the smoke jumpers to steady themselves while standing on the step outside the door.

The selected training outfit, consisting of the Eagle 30-foot backpack and 27-foot emergency chest-pack canopies with quick detachable harnesses, proved satisfactory. A two-piece, felt-padded suit, football helmet with wire-mesh face mask, athletic supporter, ankle braces, combined back and abdominal braces and heavy logger boots completed the attire of the jumpers and provided protection from the hitherto unknown hazards of timber jumping.

There is no record of any fire jumps during 1939.

Conclusions drawn from the experiment were:

1. Smoke jumpers could land safely in all kinds of green timber cover common to the Chelan National Forest. Its major timber types—subalpine, lodgepole (mature and immature), mixed north slope Douglas-fir and wastern larch, ponderosa pine and hardwoods—are common to many areas in the western national forests. The experiment thereby proved that jumping could be done successfully in most of the green timber areas, except those of the tall west coast Douglas-fir and redwood types, providing terrain was satisfactory.
2. Successful jumps could be expected in mountain meadows, open ridges, and steep open slopes if boulders were not too close together. Elevations under 7,000 feet above sea level offered no obstacles.
3. Snag areas, areas of down timber, lodgepole deadenings, extremely steep slopes, deep canyons, and areas of rock cliffs or ledges should be avoided.
4. Jumpers experienced less fatigue in jumping than would result from a short hike up a steep hill.
5. The denser the stand of timber the easier the landings and the less shock experienced by the jumpers. Landings in thickets of young trees and reproduction were termed "feather bed" landings because of the manner in which the vertical descent of the smoke jumper was checked.
6. Retrieving a parachute canopy from the crown of a tree or trees is a problem.
7. The ability to steer the type of parachute used contributed greatly to accuracy in hitting the ground target even when ground wind was stronger than 10 miles an hour. Gusty winds are much more troublesome than stronger steady winds in that the unexpectedness will cause a 200- to 300-foot drift before the jumper can maneuver to compensate.
8. The type of parachute used had a natural forward glide in still air of from 5 to 8 miles per hour; this could be used to advantage by facing into the wind, thereby reducing the drift over the ground by a like amount.

9. There was no evidence of fear or panicky state of mind even in first-time jumpers.

The primary conclusion of the experiment was that delivery of fire fighters to fires via airplanes and parachutes could be done and without injury to the men engaged in such work. This conclusion led to the next phase of the smoke-jumping program; namely, the development of plans for actual operations to be undertaken in 1940. The dreams of many firemen were at last to be realized.

Reports and cost estimates were made, equipment and personnel specification written, equipment and supplies purchased during the winter months. Since this was a new project specifications had to be developed and firms found that would be interested in furnishing much of the nonstandard pieces of equipment. Administration, training, and operation plans were also prepared.

The thoroughness of the preliminary planning by Region 6 personnel was a vital contributing factor to the success and safety record of the experiment. The safety measures then devised have been followed with success as history in following years shows.

1940

Region 1 (Northern Region) and Region 6 each organized a small squad of smoke jumpers for the 1940 fire season through recruitment of the younger men from among their most experienced firemen. Region 6 was fortunate in having two professional jumpers who had gained some experience through the 1939 experiments. The Region 1 squad had no previous training in this type of work.

Frank M. Derry of the Eagle Parachute Co. was retained by the Forest Service to serve both regions during the training season. Region 6's squad of seven men was trained at the Winthrop base in Washington. The project leader from Region 1 also received his orientation there. He then returned to his region to supervise the training of its squad at Seeley Lake about 35 miles from Missoula.

After training the Region 6 squad was stationed at the Winthrop base and the Region 1 squad at Moose Creek Ranger Station, Bitterroot National Forest. The Region 6 squad jumped to only two fires during the season. The small squad at Moose Creek saw action on nine jumper fires.

The first actual fire jump in the history of smoke jumping was made by Rufus Robinson at 3:57 p. m., July 12, 1940, in connection with initial attack operations on the Martin Creek fire, Nezperce National Forest (Region 1). Earl Cooley is credited with making the second actual fire jump on the same fire. They were the only two to jump to that fire. Control was established by 10 a. m., July 13. Of historic note also is the first successful "rescue jump" made by smoke jumper Chester N. Derry 3 days later to an airplane crash on the Bitterroot National Forest.

According to Region 1 estimates the total cost of the smoke-jumping operation during 1940—including personnel, depreciation on equipment, and flying—was $9,047. They estimated that the nine fires controlled by smoke jumpers would have cost $32,270 if ground crews alone had been employed.

On the Chelan in Region 6 a fire at the head of Little Bridge Creek was jumped by Lufkin September 10: a second fire was jumped on Twenty-Mile Creek, September 11. These two could have been very serious fires costing a lot of money to control except for smoke-jumper action.

An interesting side light—and one of far-reaching effect—pertains to the visit of four United States military staff officers to the smoke-jumper training camp in June. One of them, Maj. William Cory Lee, later employed Forest Service techniques and ideas in organizing the first paratroop training at Fort Benning, Ga. Major Lee subsequently commanded the 101st Airborne Division which he took to England and trained for the Normandy invasion. He became first chief of the Airborne Command and is regarded as the unquestioned father of United States airborne doctrine.

High lights of the 1940 season:

1. Smoke-jumping operations were successfully applied to 11 fires.
2. No incapacitating injuries resulted from the 1940 operations.
3. Project Leader Lundregan of Region 1 believed that delivery of skilled and well-trained fire fighters by parachute could be done successfully in rough timber terrain in winds up to 30 miles per hour and at altitudes up to 8,000 feet above sea level. (NOTE.—Later indicators pointed to maximum velocities of more nearly 20 to 25 miles per hour with presence or absence of gustiness being probably more important than velocities.)

It was concluded that—

4. Parachuting as an aid to forest fire control would probably not prove economic in forest areas where the road system provides ready access for ground forces.
5. Smoke jumpers should be between 20 to 35 years of age and not over 190 pounds in weight.
6. Smoke-jumping operations should continue in 1941.

1941

All smoke-jumping operations were confined to Region 1. Increased funds allowed expansion to a 4-squad outfit of 26 men, including all of the jumpers who had served the previous year. One squad was located at Moose Creek on the Bitterroot, one at Big Prairie on the Flathead, and one at Nine Mile Camp a short distance from Missoula. Thirty-four jumps were made on nine fires—three on the Chelan, two on the Bitterroot, one on the Lolo, and three on the Flathead. Some of the jumps on the Chelan National Forest were several hundred miles from the operating base.

Region 1 stated in its report, "An impartial reviewer of the season's fire control activities would have to admit evidence shows that we 'missed the boat' in a few cases." Supervisor Harris of the Chelan wrote: "Conditions seemed too favorable to justify smoke jumpers at the outset on the Route Creek Fire. 'Back sight' now points out clearly that smoke jumpers would have saved $12,000 in suppression costs. With our 'easy season' in Region 1, we cannot point to any net probable savings, but it appears that we may have been a little slow in ordering out the jumpers on at least one fire which eventually ran into money."

Estimates for the season indicated that the ratio of benefits to costs was about 10:1 or about $33,875 to $3,410 on nine fires. This estimate indicated the need for a system of selection that would assure the use of smoke jumpers on fires that have major conflagration potentialities.

Important developments of the season:

1. A static line adapted to the Eagle back-pack and used throughout the season. This device, which eliminates the manually controlled rip cord, appeared to have a remarkable effect on the trainees; it reduced the intensity of nervous reactions that generally precede first fire jumps.
2. Dr. L. P. Martin of Missoula, locally known as the jumping doctor, continued his jumper training and expressed his willingness to make parachute jumps to injured or helpless individuals in the back country. This resulted in a plan for a jumping squad to be available to render first aid in inaccessible areas.
3. The Ford Tri-motor and Curtis Travelair type airplanes proved admirably suited to smoke-jumping operations.
4. For the first time an organized force was jumped to a threatening fire that had escaped from the initial attack forces and had reached an area of 15 acres in very bad fuels. The jumpers were able to hold the fire in check until additional ground forces arrived.
5. Accidents due to jumping can be held within an acceptable tolerance ratio.
6. It was demonstrated that smoke jumping is a practical possibility.

1942

The project continued in Region 1, and location of the squads was the same as in 1941—Moose Creek, Big Prairie, and Nine Mile Camp. A further expansion led to a 4-squad unit and only the impact of World War II prevented greater development. Because of the war, age limits and experience requirements had to be liberalized though physical standards were not lowered. Training was undertaken with but 5 experienced men. Of the 33 recruits to be trained only a few were experienced smokechasers. This necessitated a greatly intensified program of fire control training in addition to the jumper training.

The equipment situation was very critical. Occasionally a few chutes not acceptable to the Armed Services were obtained and converted. Experimentation resulted in an outstanding development in aerial fire control—the Derry slotted chute. This chute is easily opened and maneuverable, and provides a slow descent and better oscillation. It was found that any standard, flat-type parachute could be converted by adding slots and guide lines.

Thirty-one fires were jumped by smoke jumpers during 1942. The savings in suppression costs were estimated to be $66,000 because the fires selected for the jumpers were potentially bad ones. As in previous years, accidents were few and were therefore not considered to be a bar to the future of the program.

1943

The manpower shortage had reached a very critical stage, and only five experienced jumpers returned to the project. Inquiries were received from 4–E draftees (conscientious objector) in Civilian Public

Service (C. P. S.) camps who wished to secure noncombat work of the nature afforded by smoke jumping. Sixty candidates were selected, a majority of whom were from the "peace churches"—Mennonite, Brethren, and Friends.

Regions 4 and 6 reentered the project with Region 1, each sending fire control men to Missoula to be trained as squad leaders and riggers to serve as overhead for C. P. S. squads that would be assigned later. Facilities for training were enlarged at Seeley Lake by the addition of an obstacle course, a plane mock-up, and some lesser improvements in equipment. About 70 new men were trained during the 1943 season and again there were no failures. However, a few received minor injuries in training which prevented them from jumping to fires during the summer.

The smoke-jumper program for the summer involved 4 squads or 48 men for Region 1, 1 squad or 11 men for Region 6, and a 5-man squad for Region 4 (Intermountain)—a total of 64 men. The Region 6 squad, under the direction of Jack Heintzelman, was located at the Redwood Ranger Station, Siskiyou National Forest, Oreg.; the Region 4 squad was stationed at McCall, Idaho, Payette National Forest; final distribution for Region 1 was 12 men each at Seeley Lake, Big Prairie, Moose Creek, and Nine Mile Camp.

Thirty-one fires, involving 94 individual jumps, were recorded for Region 1 squads, 6 fires for Region 6, and a few fires for Region 4, for a season's total of about 40 fires.

An indicated savings of more than $75,000 is attributed to the use of smoke jumpers on fires in 1943.

High lights of the 1943 season:

1. Training of parachute rescue units involving 25 men from the United States Coast Guard, Canadian Air Observer Schools, and United States Air Forces. About half of the men trained were flight surgeons.
2. The Derry slotted chute proved successful and popular with the jumpers.
3. Conscientious objectors were used to advantage as jumpers.
4. Again, accidents did not prove a bar to continuance of the program.

1944

C. P. S. men continued to be the reservoir of manpower for the project, with nearly 60 percent of 1943's group returning. Distribution of the men was about the same as in 1943 but with changes in the numbers of jumpers assigned the 3 regions. Approximately 120 men took part in the program. Training of the new men continued to be confined to Region 1, as was most of the refresher training of the experienced men.

A further centralization of smoke-jumper use in Region 1 led to a changed arrangement of forces at the various bases. A stand-by unit was held at Missoula; the number of the men in the squad could be raised according to potentialities of use by drawing from outlying feeder bases where 40 to 50 jumpers were kept, many on work of project nature.

There was a considerable increase in smoke-jumper use in 1944. Nearly 100 fires were handled—about 75 percent from the Missoula base. Jumpers were used on larger fires than previously and in larger groups. Substantial suppression savings were made.

Important developments in 1944:

1. Smoke jumping was no longer on an experimental basis; it was considered as a routine operational feature of the over-all fire control job in Regions 1, 4, and 6.

2. Smoke jumpers were used in Region 5 for the first time. They jumped to one fire on the Happy Camp District of the Klamath National Forest.

3. A method of guideline attachment allowing faster and easier manipulation of the canopy was developed, tried out, and pronounced successful.

4. A new simplified technique in let-down from trees was perfected.

5. Perhaps the most significant change was in Region 1 where parachute jumpers were included in the regular organization. Previously, the smoke-jumper unit was organized as a special force—an adjunct to the ground forces, financed from special funds. Some national forests for the first time reduced the number of back country smokechasers, thus becoming wholly dependent on smoke jumpers over considerable areas.

6. Nineteen hundred and forty-four was the first year in which considerable use was made of military aircraft for smoke jumping in Region 6. In Regions 1 and 4 Ford Tri-Motor and Curtis Travelairs continued to be the mainstay for smoke-jumper transportation.

7. Continued low-accident rate in smoke-jumping operations proved the safety measures observed and intensive training of smoke jumpers were successful and that the program could be expanded, if necessary, without particular worry concerning accidents.

1945

Nineteen hundred and forty-five was the last of the war years. Continued expansion of the C. P. S. program and the return of war veterans permitted an increase in the total number of smoke jumpers in the 3 regions to about 220 men, of which nearly 100 were seasoned smoke jumpers. Training of new men and most of the refresher training of the returnees was conducted under the direction of Region 1 at the Nine Mile Camp out of Missoula.

Distribution for the season resulted in increased quotas of jumpers: Missoula, Mont., 153; McCall, Idaho, 36; Twisp, Wash., 15; and Cave Junction, Oreg., 15. The 153 men were not actually located in Missoula. Missoula was used as a base of operation to which smoke jumpers could be brought as the need developed.

Use of smoke jumpers was very high during the period July 11 through the first week in September. In the 3 regions smoke jumpers were used on 265 fires involving 1,236 individual jumps. These jumps were to potentially serious fires on 23 national forests in Montana, Idaho, Washington, Oregon, and California, and to fires in Yellowstone and Glacier National Parks, United States Indian Service lands, and private timber association lands. Also, the first jump by smoke jumpers over the international boundary in Canada was made.

A partial analysis of suppression costs indicated a savings of $347,000 for the season's operations.

Most significant events in 1945:

1. First experimental "Air Control Area"[2] involving 2 million acres of roadless wilderness. This area included parts of the Flathead, Lewis and Clark, Lolo, and Helena Forests in Region 1, and became known as the Continental Unit. Aerial detection and smoke jumping almost to the exclusion of ground forces work were used.
2. Additional training of military men in parachute work pointed at aerial rescue operations.
3. First active collaboration of smoke jumpers and army paradoctors cn rescue missions. Air-rescue jumps for the season were 55.
4. Training of the 555th Battalion of Negro paratroops in timber jumping and fire fighting to combat Japanese balloon fires. Ninety-seven Negro paratroops were jumped on the Bunker Hill fire and 28 on the Heather Creek fire, both on the Chelan. Regular smoke jumpers were used as overhead. In addition, 6 made jumps on the Rattle Snake fire, 10 on the Lemon Butte fire and 4 on the Copeland Creek fire, all on the Umpqua National Forest.
5. The loan of two UC–64 Noorduyn Norseman airplanes from Army for use in Region 6.
6. Standardization of (1) qualifications of men selected as smoke jumpers, (2) training technique, (3) jumping gear, such as parachutes, suits and other rigging, and (4) jumping technique.
7. Air transportation demonstrated as a quick and effective means of placing skilled, hard-hitting crews on fires that might otherwise prove serious, and also for placing additional forces on fires escaping initial attack crews.
8. The testing of quick-release type harness. This harness had advantages over the old type since it simplified "tree let downs" and was designed to fit any size man. Regions changed over to this type of harness in 1948.

1946

With the end of the war, the C. P. S. program was liquidated. Only a small group of trained smoke jumpers remained, and it was necessary for the regions to recruit large numbers of civilians to be trained.

The over-all number of jumpers and their distribution to operating bases remained about the same as in 1945. Of Region 1's group of about 160 jumpers, 84 percent were ex-service men and about 40 percent were college students, many taking up forestry as a career. The Yellowstone and Glacier National Parks and the California Region participated financially for the first time in the program.

A C–47 airplane was added to the contractor's fleet making it possible to transport larger crews at greater speed.

Three hundred and twenty fires involving 1,111 individual fire jumps resulted from the 1946 operation. This was an increase of 51 fires over the previous year.

Savings attributed to the Region 1 part of the operation (202) fires was $376,000.

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[2] For further information see FIRE CONTROL NOTES 1947, vol. 8, No. 1, pp. 28–32.

1947

There was no radical change in the operational features of the program or in the number of jumpers employed. Of interest, however, was the degree of turn-over; about 50 percent of the previous year's men returned. This helped to reduce the job of training. The season was less severe than that of either 1945 or 1946. Consequently fewer fires were attacked from the air. A total of 932 individual jumps were made on 192 fires.

High lights of the 1947 season:

1. Regions 4 and 6 developed their own training centers and conducted their own parachute training.
2. A foreman and eight jumpers from Region 1, with a Noorduyn Norseman plane and pilot from Region 6 were detailed to the Gila National Forest in Region 3 (Southwestern) for the period May 25 to June 25.
3. The use of helicopters to retrieve smoke jumpers and return them to interior airfields or other locations of immediate access was considered seriously for the first time. With this plan in view, experiments were conducted in Region 5 during the season.
4. David P. Godwin, who fathered the smoke-jumping operation during its initial phases and throughout the following years, died in a commercial airline crash in the Virginia mountains on June 13.
5. Smoke jumpers from the Missoula base participated in combined attacks on two fires that were bombed from the air as a part of the Forest Service-U. S. Army cooperative fire-bombing project.
6. Two groups of Air Rescue Service were trained as jumpers at the Missoula base.

1948

The number of smoke jumpers increased from 225 in 1947 to 244 in 1948, mainly because more jumpers were employed in Regions 4 and 6. The groups at Cave Junction, Oreg., and at the Inter City Airport (near Twisp, Wash.) on the Chelan National Forest each employed 28 men. A new unit of 10 men was added to the Region 4 set-up and stationed at Idaho City, Idaho, on the Boise National Forest. Region 5 entered the program by financing a leader and 3 jumpers, who were stationed on the Siskiyou National Forest and supervised by Region 6.

The 1948 fire season in the West was the lightest in many years, except in Region 3 where a severe season was experienced. One hundred fires involved but 402 individual fire jumps during the season's operations.

High lights of the 1948 season:

1. Helicopters were used for the first time to return smoke jumpers from back-country areas to places of immediate access. The first use of a heliocopter for this purpose was on July 30 and involved the Cedar Camp fire on the Klamath National Forest in California. All six jumpers with their equipment were moved out after being replaced. Two other fires jumped in Region 5 involved transportation out by helicopter. Nine smoke jumpers and gear were retrieved in this manner for the first time on the Chelan on August 4.
2. Special lengthy reports were eliminated because smoke-jumping operations had become generally accepted as routine.

3. Helicopters were used for the first time by Region 6 for initial attack on the Snoqualmie National Forest.

1949

There was very little increase in the number of smoke jumpers employed in 1949, and operational procedure remained about the same. Region 1 had 150 jumpers with the primary base of operations at Missoula, Mont.; Region 4 had 11 jumpers at Idaho City, Idaho, and 35 at McCall, Idaho; Region 6, 28 at Cave Junction, Oreg., and the same number at Inter City Airport, Wash.—a total of 252 men. The 8-man unit from Region 1 was again detailed to the Gila National Forest in Region 3 during May and June. Region 5 financed 8 men from the Siskiyou, Region 6, to serve the needs of 5 northern California forests.

There were 354 fires jumped in 1949, involving 1,335 individual jumps. This was the largest number of fires and the greatest number of jumps since initiation of the program in 1940. The estimated savings in suppression costs exceeded $900,000 for the season.

Helicopters were used on more fires to return smoke jumpers to points of immediate access than during 1948, principally in Region 5 where four fires were involved. Initial attack was made by helicopter on fires in Region 1 and the Wallowa in Region 6—a small beginning, but a gain in experience in the use of this craft.

Summary of Smoke-Jumping Activity 1940–49

Year	Smoke jumpers	Fires jumped	Average fires jumped per crew	Individual fire jumps	Average men per fire	Average fire jumps per man
	Number	*Number*	*Number*	*Number*	*Number*	*Number*
1940	14	9	0. 64	[1] 27	3. 00	1. 93
1941	26	9	. 34	[1] 30	3. 33	1. 15
1942	32	31	. 99	[1] 100	3. 22	3. 12
1943	64	40	. 62	[1] 130	3. 25	2. 03
1944	120	100	. 83	[1] 350	3. 50	2. 91
1945	219	269	1. 23	1, 236	4. 60	5. 64
1946	229	320	1. 40	1, 111	3. 47	4. 84
1947	225	192	. 86	932	4. 85	4. 14
1948	244	100	. 41	402	4. 02	1. 64
1949	252	354	1. 39	1, 335	3. 77	5. 29
	1, 425	1, 424	1. 00	5, 653	3. 96	3. 97

[1] Estimated.

RANGER DISTRICT ORGANIZATION ON HIGH DANGER DAYS

PAUL M. KIHLMIRE

District Ranger, Clark National Forest

The fire presuppression job which makes large demands on the ranger's time is the preparedness and organizational planning on high fire danger days. This planning supplements the annual fire plan and all the other guides used in fire control. It concerns the day-by-day and hour-by-hour maneuvering as fire danger builds up and continues high over several days.

The planning starts the afternoon and night before anticipated high danger days and is a continuous action over sustained high danger periods. Initial plans are made by the ranger during early afternoon, expanded and fully developed as soon as possible the same night by the ranger and his staff. These plans include:

Weather reports.
Follow-through action.
Regular personnel.
Lookouts.
Fire crews.
Equipment (mobile and special).
Fire tools.
Food and supplies.
Overnight watch and fatigue plans.
The situation.

Weather reports.—Assemble all weather reports received by dispatcher during the day and correlate with special weather information relayed from the supervisor. Check these reports against local radio and newspaper forecasts. This data will give a trend and is used to calculate probable fire dangers. The anticipated danger becomes the basis for adjustments in the fire control organization to meet the change in conditions.

Follow-through action.—Secure data on all reportable fires, false alarms, and nonstatistical fires for the period. Estimate the mop-up and patrol job as carry-over suppression work to be dovetailed into the plans for fire inspections and fire investigation. This information gives the pattern for assignment of regular personnel and the need for supplementing this personnel with outside help.

Regular personnel.—Each of the regular personnel is given an assignment for the following day. His geographical location is definitely determined and his means of communication with the dispatcher established. Each man is assigned a piece of equipment and has a specific fire job to perform. On large fires each man has a special assignment to best utilize his abilities in the large fire organization. This is also true in the high danger day organization where the placement of personnel is determined by fire occurrence, fire mop-up and inspection, fire investigation, and the distribution of fire tools, food, and supplies.

Lookouts.—The tower-manning requirements are reviewed in line with expected weather, visibility, and period of time the towers have been manned. Secondary towers may be needed and the personnel to man them mobilized. Alternates for the regular lookouts are necessary to rest the regular towermen. The normal morning check-in time and the night check hour may be changed to meet local conditions during high fire danger. (Experience has proved a 10 p. m. night check may be much more effective than an 8 p. m. check the night of a pie supper or revival.) Windy nights require all-night detection and dispatching.

Fire crews.—Determine number of fire wardens and fire fighters needed for the anticipated danger for the following day. Request for approval on needs beyond authorization. Send orders to wardens on size of crew wanted, where to report, and work assignment upon reporting. Consider the current day's work by fire crews to keep initial attack force fresh and effective mop-up jobs completed early. An additional task on these days is expansion of mobilization to include seldom-used wardens and the hire of additional equipment.

Equipment (mobile and special).—This phase of the planning includes the placement of equipment and personnel assigned. Tankers and plows are located for initial attack determined by terrain, fuel type, risk, and accessibility. Follow through on operating condition and readiness for call.

Fire tools.—Needs of fire crews and means of delivery scheduled. Warehouse fire-tool replacements are requisitioned currently to maintain the authorized fire-tool complement. Inspection of fire-tool maintenance and distribution assigned.

Food and supplies.—The dispatcher keeps a want list for food, rations, and miscellaneous supplies needed by wardens, lookouts, and field crews. Purchase and distribution is scheduled and assigned to regular personnel, except on large fires where a separate service of supply is set up.

Overnight watch and fatigue plans.—Plans are made for alternate dispatcher or at least telephone operator to take night calls when towers are manned all night. One of the regular personnel is assigned to be called when action is needed. Both days and hours are staggered as much as possible to keep fatigue at a minimum.

The situation.—The planning action is summarized and a report telephoned to the forest supervisor. Approvals are secured and any changes for forest-wide fire-control needs are incorporated into the organization for the district.

Briefs for newspapers and press releases in outline form are made ready since all information is available.

This check-list planning gives the administrator the pulse of his organization. The staff conference, informal and short, enables the regular personnel to report on the effectiveness of the various wardens, how the fire crews performed, elimination of "goldbricks," and the ever-present job fire possibility. The total work load can be equalized; above all it is an ideal time to break down the tension of high fire danger.

FIRE FIGHTING ORGANIZATION AND WARDEN SYSTEM

Gifford B. Adams

District Ranger, Clark National Forest

[Following is the district organization with emphasis on the fire-warden system to effect economical fire control.—Ed.]

District ranger (full time).—Free to carry on other field duties, either fire or project, except when a fire situation develops, or on days of high fire danger. In touch with dispatcher or tower by radio at regular call times. Takes initial action when feasible. Usually takes charge of first large fire, and worst fire when several serious fires are going. In touch with dispatcher by radio to correlate over-all fire picture. Is accompanied by five- to six-man fire crew during high danger days.

Forestry aide (full time).—This employee is dispatcher approximately 90 percent of the time. He does most of the dispatching on high danger days and during bad fire situations. He is assigned to enough fires each year, as fire boss, to keep in touch with actual fire fighting and to keep oriented on crew capabilities, communications, and other field conditions indispensable to efficient dispatching.

Fire control aide (fire season only).—Handles initial attack on majority of fires occurring within his reach on bad fire danger days. Usually has "hot shot" crew of well-trained men on four-wheel-drive jeep pickup and pumper. Acts as dispatcher on occasion. Capable of handling large fires. Usually first reinforcement when a warden and crew has taken initial action.

Strawboss (fire season only).—Handles some initial attack on low hazard days. Usually reinforcement. Will be capable of handling large fires with additional experience and training.

Primary warden system.—The primary wardens are the backbone of the fire fighting organization. Each warden, who is well-trained and experienced, has a crew of 3 to 10 dependable local men and a truck equipped with fire tools, rations, radio or, in some cases, a portable telephone. These self-contained warden units are used to a large extent for initial attack in their local zones where they are most familiar with the roads and trails, and local conditions. In bad fire situations they are used extensively as reinforcements and so gain experience in other areas.

Many considerations are involved in the organization of a good warden system. The value of a warden depends on his availability when needed. skill at finding and controlling fires, leadership, local acceptance (which is extremely important), need of employment, interest in the fire control job and ability to exert fire prevention influence among his neighbors.

The warden should be properly located as to fire risk and means of communication. He must own or have access to a motor vehicle and must be able to arrange his farm or other work to permit availability for fire work. It is very seldom that a prospective warden meets all the above qualifications. A compromise on one or more points is usually necessary.

The warden organization must be maintained throughout the year. Probably the most important factor in such maintenance is the casual contacts of the year-long personnel with the wardens from time to time. At these frequent contacts a warm personal interest in the warden, outside of fire problems, and a sharing with him of new developments in the Service go far to maintain morale and improve future value of the warden. A 1-day training session is held each year in February, at which time teamwork is stressed as well as individual items of fire prevention and fire control work. At this time a special effort is made to make these men feel that they are a valuable and necessary part of the Forest Service organization.

Every opportunity must be taken to give the warden on-the-job training, and under Clark fire conditions it is not difficult to find such opportunities. It is also possible to give additional training and responsibility to promising wardens so that they will be capable of handling larger problems in the future.

One difficult task is to balance employment of wardens with forest fire fund standby authorizations, problems of risk and danger, and desire of the wardens for employment. The morale of the warden organization hangs on a delicate day-to-day manipulation and balance of these factors. Some wardens want all the employment they can get, while others wish to be called only when absolutely necessary. Limitations of funds holds the number of primary wardens within the number that can be employed to a sufficient extent to maintain their active interest.

The importance of communications with wardens can hardly be overemphasized. Their value in quick fire control depends on prompt communication. Whenever possible, connections are made with Forest Service telephone. Some more important wardens, off the telephone lines, are given radios, and in some cases they must be reached by messenger from the towerman, or by taxi or other means.

In all cases an effort is made to secure some degree of fire prevention by the wardens. The effectiveness in this field varies considerably by individuals. When the warden is a leader in the community we get good returns. In any case the warden must be respected by his neighbors or much damage to the prevention effort becomes evident. As a general rule, the warden has limited value as an enforcement agent. As long as respected neighbors sincerely believe in the value of woods burning, any active participation by the warden in enforcement endangers his value as a prevention and control agent.

Secondary warden system.—The secondary warden may be described as a man strategically located from a fire control standpoint and who is actively interested in keeping the fire out of the woods, but who does not meet the requirements of a primary warden. Lack of communication due to isolated location usually makes the difference. This type of warden is supplied with tools and takes independent control action when a fire occurs in his immediate locality. This type of warden has limited value except in rare cases, such as a blow-up situation. His greatest value is probably in the field of local fire prevention.

High school crews.—Two high schools on the district are often called on for fire crews. One of the seniors with leadership ability and experience is set up as a warden and fire crews are arranged through him. One good 10-man crew can be depended on from each school, and an additional 20 men from each in an emergency. Other high schools on the district can furnish untrained crews in emergencies. The high yearly turn-over of trained men from schools limits the value of this source, although this same factor increases the fire prevention potential as these young, trained men become distributed throughout the district.

Industrial crews.—A cooperative agreement is held with the local lead mining company which has extensive land holdings adjacent to the district. This agreement calls for mutual aid. The Forest Service furnishes fire tools and trains key mine foremen. It also spots fires on or adjacent to mine lands and reports them to the company. The mining company agrees to furnish men up to their full complement in case of fires threatening both Forest Service and mine lands.

Cooperators.—This includes a miscellaneous group of people interested in fire prevention and fire control who do not wish to be called for routine fire control activities because of their extensive private interests, but who will respond in a serious situation in any way they can help. These may be ex-Forest Service personnel, business men, or large farmers.

Fire control handbook.—All basic material necessary to the functioning of the fire control organization is maintained in a fire control handbook on the dispatcher's desk. For quick and economical revision all changeable information is recorded in pencil longhand. This basic material is given a major revision just before the spring fire season, and then is revised currently throughout the year as changes occur in the organization.

LET'S CHANGE OUR HEADLIGHT CIRCUIT

Alva G. Neuns

California Forest & Range Experiment Station

One thing, they say, leads to another. In this case a search for a throw-away headlight outfit for use on fires led to the discovery that we aren't getting the most for our money out the the present model. In fact, the lamp and battery circuit used by the Forest Service is the least efficient of three tested by C. C. Buck and W. L. Fons at the California Forest and Range Experiment Station.

On the assumption that the current drain on the batteries may be too heavy in the headlight circuit now in use, two other circuits were suggested. All three were set up for comparative measurement. Figure 1 shows diagrammatically the kinds of lamps and batteries used and the hook-up and operation of the lamp and battery circuits. There are four batteries in each circuit. In circuit I (Forest Service) and circuit II they are arranged in two parallel pairs, A and B. Circuit I draws current from battery pair A or battery pair B. Circuit II draw simultaneously from both pairs and circuit III uses current from all four batteries in series.

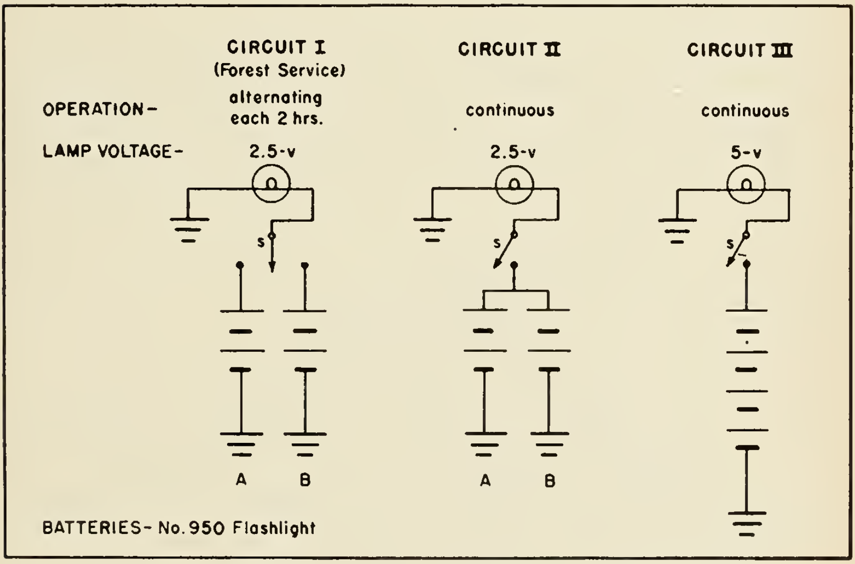


Figure 1.—Wiring diagram for three electric headlight circuits.

An 8-hour period of good light was considered to be a minimum requirement, so the study was set up to cover this period. Circuit I operation is based on the fact that batteries will recuperate if allowed a rest period. Therefore, contact is alternated between battery pair A and B every 2 hours. Circuit II relies on continuous operation of both pairs and circuit III on continuous operation of all four batteries in series.

In order to stabilize fluctuations in light output, usual in bulbs at the beginning of use, each new bulb was allowed to burn 20 minutes prior to measurement. Battery performance was checked by duplicating the observations using the batteries of a different manufacturer. Results were identical in both tests.

Current flow of each circuit during the 8-hour period was measured continuously with a recording milliammeter. Comparative light output of the three bulbs was also measured with a University of California Department of Engineering photoelectric cell photometer for a number of values within the ranges of current flow through the lamps recorded in the individual tests. From both these measurements the light output values were computed for each circuit during the eight hours (fig. 2).

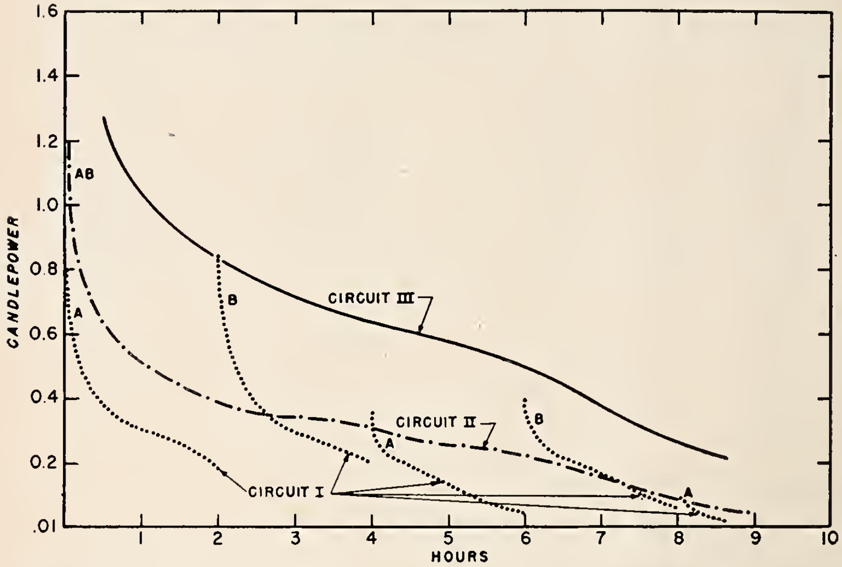


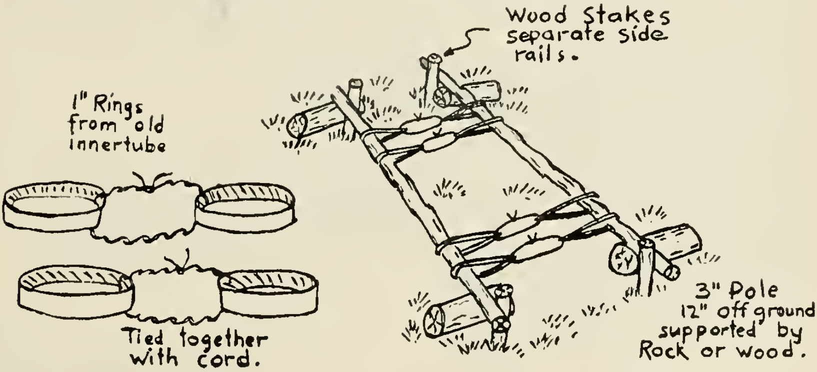
Figure 2.—Light output of three electric headlight circuits over an 8-hour period of operation.

Study of figure 2 will show circuit III to be superior throughout 8 hours of use. At the end of 2 hours it was equal in strength to the initial output of circuit I operating on battery pair A or B; after 3 hours it was still equal to A or B after only 10 minutes use. At no point was it as low as circuit II or circuit I. Note the immediate fall in output and the relatively small recovery after the rest period observable in the alternated pairs of circuit I. Circuit II is a little better than circuit I in that its light output remains more constant. It does not fall as low at any hour as circuit I does at the end of each 2-hour-use period. Both circuits I and II fall off more rapidly than circuit III.

Besides being least efficient the present Forest Service headlight has an added practical disadvantage. The user must remember to switch from one pair of batteries to the other in order to provide them with occasional rest periods. Ideally, this should result in a usable light continuously for 8 hours. Actually, this is seldom the case. A man on a fire or any other job cannot be expected to spend time or thought on how to operate a flashlight.

Even though circuit III is obviously the best of the three, it presents a problem in that it uses a 5-volt bulb instead of a 2.5-volt one. This would require changes in the present headlight assembly. A new reflector has already been designed but expense of cutting the die necessitates the creation of an adequate market before the cost can be justified and manufacture begun. The same holds true to a lesser extent for a new throw-away battery case. The throw-away unit would be ideal for fire use and will eventially be made for that purpose. For general use, however, it should pay to develop the new reflector and modify the present case in order to take advantage of the strong adequate light provided by circuit III during the entire use period.

Portable Bedsprings.—How many foresters and firefighters have laid their hips on a bed of rocks or hard ground night after night in an effort to get a good night's rest after a tough day? How can this be avoided without too much cost or effort in pruning all the boughs from young thrifty trees? I think I found the answers in a logging camp visited in northern Maine last summer. (This statement is qualified because I have not tried the device.)


Wood Stakes separate side rails.
1" Rings from old innertube
Tied together with cord.
3" Pole 12" off ground supported by Rock or wood.

Here it is: Cut about a dozen strips an inch or so in width from an old auto inner tube. Hook six on either side of a 6-foot pole. Spread the poles far enough apart for a comfortable width bed, tie the pieces opposite each other together with cord, elevate the poles or frame about a foot off the ground and lay bed on top. The illustration gives a pretty good idea of design. Strips may be placed as close together as necessary, depending on weight of individual.

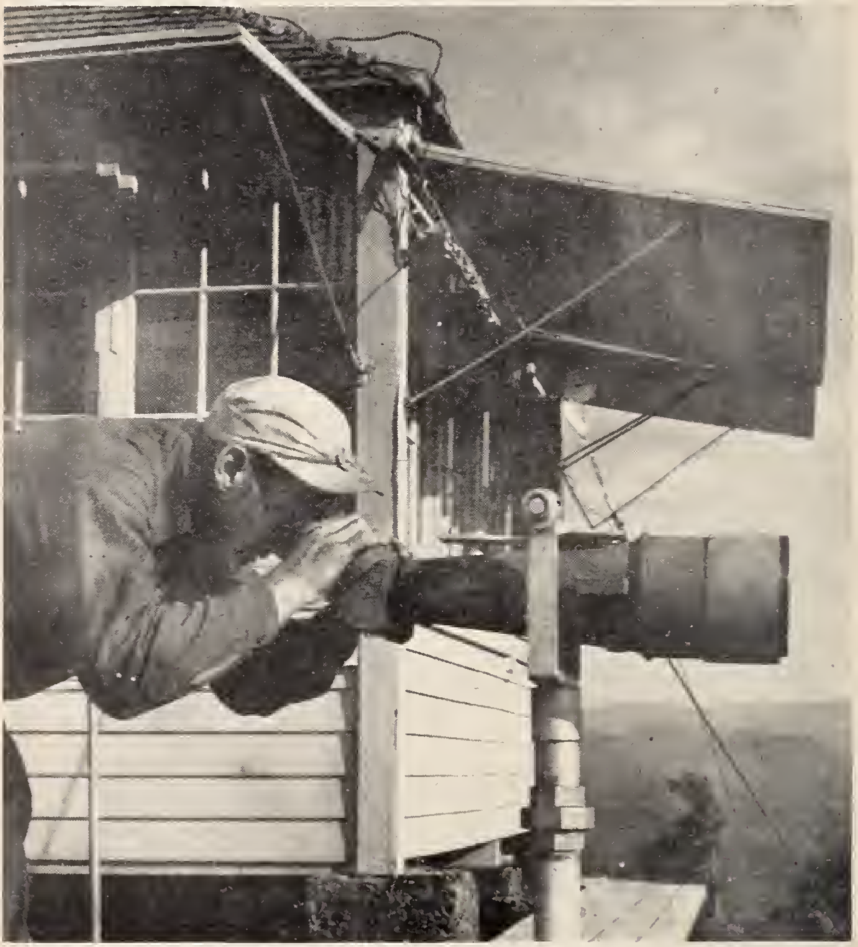
An alternate suggestion is to use three loops of inner tube, tying together with square knots, eliminating the string.—ED RITTER, *Forester, Region 7, U. S. Forest Service.*

SPOT FINDER BOARD AND BINOCULARS ON LAVA BUTTE

E. J. Parker

District Ranger, Deschutes National Forest

A spot finder board and heavy Japanese binoculars were set up on Lava Butte in 1947 for the use of the public visiting the lookout. The finder board was constructed by tracing the outstanding features from a standard one-half-inch forest map on a piece of plywood that had

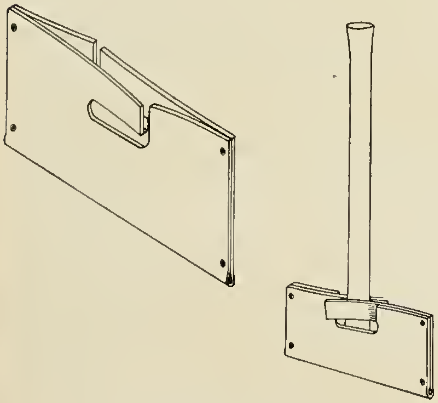


Heavy Japanese binoculars on Lava Butte, Deschutes National Forest, Oreg. The spot finder board is mounted off to the left.

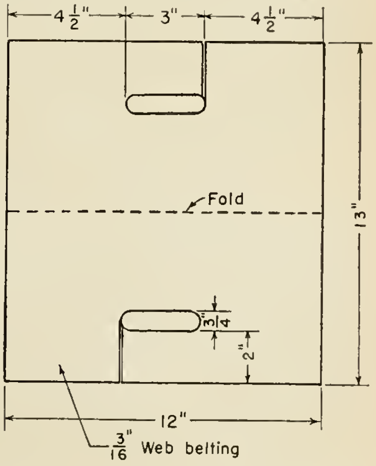
been painted silver gray. The summit of the Cascades, peaks, lakes, and rivers were inscribed in black or dark blue india ink. Holes were drilled in the board for mounting upright pegs over the summit of each visible peak. The key peg for Lava Butte was painted red, and the others silver. The air-line distance from Lava Butte and the elevation of each peak was inscribed on the map. After the board was oriented on the ground and fastened to four vertical pipes, it was possible for the public to determine the various peaks by simply stooping over and lining up the red peg with any one of the silver pegs. Though no lakes were visible from Lava Butte, their location in reference to the outstanding peaks was of interest. Instructions for use were printed in one corner of the board. The board was protected by giving it two coats of spar varnish before mounting.

The mount for the heavy Japanese binoculars was constructed by Mr. Westcoatt of the Departmental Shop. The binoculars were hung by means of a vertical tilt spring and friction bolt and the assembly pivoted on a threadless pipe cap. The public seems to enjoy using these fine glasses, and 10,000 people annually make Lava Butte one of the most visited lookouts in the Pacific Northwest Region.

Inexpensive Ax Sheath.—Ax sheaths or other protectors for ax blades have long been recognized as essential from both a safety standpoint and to protect the blade. The loss of sheaths on going fires is unusually high and in recent years the cost of replacement excessive. In an effort to solve the problem at minimum cost, Ranger Cleo J. Anderson began experimenting with different materials and methods. The best solution seemed a sheath of scrap webbing 3/8 inch thick. This was split to give a better thickness to work. The 3/16-inch webbing is still more durable than leather and only slightly heavier. The material is cut to a pattern with grooves to fit over handle and joined by two rivets on each end. Straps, buckles, and carrying ring can be added if desired.—Perl Charles, *Assistant Supervisor, Tonto National Forest, Ariz.*



AXE SHEATH



THE MOUNTING DOUGLAS-FIR SLASH PROBLEM IN WESTERN OREGON AND WASHINGTON—WHAT CAN WE DO ABOUT IT?

Kermit W. Linstedt

Chief of Fire Control, Region 6, U. S. Forest Service

Currently there are about 25,000 acres of national-forest lands being cut over in western Oregon and Washington each year.

When areas on which disposal by broadcast burning is not planned have been set aside and we add those planned for burning but not burned, we find that areas of unburned slash are developing at the rate of some 10,000 acres a year.

I presume the experience on national-forest lands to be little different from that on State and private lands. A problem of what to do to meet this increasing hazard becomes evident.

There are several approaches to the solution of the problem. Probably the best long-time solution lies in closer utilization. The production of plastics, alcohol, fiber board, and other comparatively new developments gives promise in assisting with the problem in a manner that certainly should not be overlooked. To the practical man who is confronted with the problem as it is today, these possibilities, which will undoubtedly be developed by science to a continuing degree, are only something in the dream stage and are not at all a solution of the immediate problem.

In Rhode Island the Soil Conservation Service has made a trial in grinding up the woods waste resulting from logging and putting it back as litter on the forest floor to enrich the soil. This is a commendable start, but like the utilization suggestion, it has not developed to the point where it offers any real solution of the slash problem at the moment.

Another approach to the problem is to leave the slash on the ground to decay by natural means and give it an additional standard of protection in that interim. This complements the first suggestion in that it permits salvage of some of the material for a good number of years after the original logging.

Experience in protecting slash areas on the ponderosa pine type adds promise to this proposal as a means of hazard abatement. Undoubtedly, there are areas and situations in the Douglas-fir region where the same is true. In all too many cases, however, accumulated slashings in western Oregon and Washington have set the stage for disastrous fires. Even with good additional protection, there exists considerable question as to whether it is reasonable to expect that we can protect these areas from fire for the time necessary to abate the hazard normally.

Under present economic conditions the major approach to the slash problem then lies in the much-debated practice of burning.

Successful disposal of slash by burning calls for complete consideration of the problem from the time the first work is done toward laying out the logging plan until the disposal fire is extinguished.

For best success in slash disposal, more effort must be expended in applying known techniques of fire fighting to this all important job. The same basic principles hold good whether they are used to suppress a wild fire or to purposely burn an accumulation of logging waste.

Many of our problems in burning slash have stemmed from a failure to recognize this clean-up after the harvest as a legitimate cost of operation chargeable to logging.

We must start with a recognition of the job to be done and the need for doing it. From there on, it becomes a matter of planning, adequate financing, and the application of the best-known techniques to the accomplishment of the job.

The staggered-setting system of cutting has probably done more than any single recent development to aid us in the solution of the mounting slash problem. This system allows a better selection of time to burn because of the limited acreage to be burned in any one unit.

In this system of cutting as in any other, strong emphasis should be placed on planning the slash disposal at the time the first cutting area is considered. There are a number of important considerations that follow on through the cutting operation and until the time of actual disposal. I will review briefly the most important of these.

1. The cutting unit should be established on the ground so that full advantage is taken of all natural topographic breaks. It is particularly important to have a topographic break at the top of a cutting unit. Minor ridges can frequently be used to form the sides of cutting units.
2. Roads can frequently be so located as to form a break at the top of the cutting area which has no natural topographic break.
3. The cutting area should be kept to a maximum of 40 to 50 acres in size if practicable.
4. All trees possible should be felled into the cutting area.
5. All trees and snags within the cutting area should be felled.
6. All dangerous snags should be removed for a distance of 200 feet around the exterior boundaries of the cutting area.
7. Fires should be set in a drying-out period after a rain.
8. The best possible weather information should be obtained prior to burning. This applies especially to winds and east winds in particular.
9. Adequate manpower should be on hand to set the fires and insure control.
10. Slopes should be burned from the top down. Level areas should be fired first on the inside and then around the edges of the cutting area.
11. When the decision has been made to burn, burning should be accomplished in the shortest possible time. Mop-up of the fire edges should be started as soon as the burning of fine fuels has been accomplished.

In conclusion, it is my opinion that we must first do all we can in utilizing what is now waste material in the woods. Secondly, when better means are not available, we must aggressively plan and execute disposal by burning most of our slash currently if we are to avoid catastrophe and accomplish the best possible management of our forest lands. We must recognize, of course, that the effect of burning on site, watersheds, and similar factors must be considered and disposal of slash through burning adjusted to meet the primary needs of these factors.

Blazing the Road to a Fire.—The first attacking crew enroute to a fire does not always find it practicable to stop and erect signs indicating the proper road to that fire. If there are numerous roads the job actually becomes time consuming. The signs placed in a hurry often blow over or get knocked down. They are difficult to see and in some cases give wrong information.

During the fire season of 1949, the following method was employed on the Saugus District of the Angeles National Forest and found to be very practical.

About a quart of flour was placed in a paper bag. The opening of the bag was folded down and taped shut. About six of these bags were placed in an easy to get to location in each fire-going vehicle on the district.

At each road fork where there might be a question as to which road to take to the fire, the flour in these bags was used to indicate the correct one. A crewman merely broke one of the flour bags, got out of the truck, and walked along side the tanker as it went through the intersection. In this manner a line of white flour about 10 feet long was deposited on the road indicating the direction traveled by the tanker. Equipment following can easily spot this white line and take the direction indicated.

It is not intended that this method wholly replace the "Fire Camp" sign, as the flour streak becomes obliterated in a short while if there is much traffic. If the fire lasts any time at all regular signs should be erected.

The main advantage of this system over the signing method is that it gets done. Members of a suppression crew seem to be anxious to leave this mark. It has an appeal that the signs seem to lack. Other advantages are that it is quickly done and much easier to see than a sign.—CHARLES T. SMITH, *Suppression Crew Foreman, Angeles National Forest.*

LIGHT DUTY POLE DOLLY

Keith C. Euler

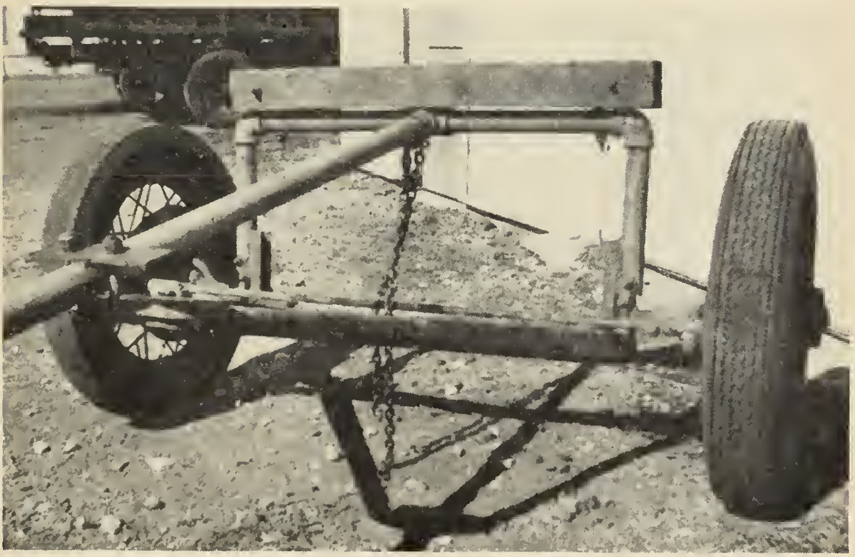
Engineering Aide, Modoc National Forest

Too often stake-side trucks have been uneconomically used to distribute one to three telephone poles on minor telephone line repair jobs. This has been overcome by constructing a light duty pole dolly for use behind a pickup.

The light duty pole dolly was constructed locally from a Ford front axle and wheel assembly and a few pieces of salvaged 1½-inch water pipe and fittings. The total cost of materials was less than $50. With this unit, the butts of up to six poles may be placed in the bed of a pickup and the dolly, fastened to a standard hitch, carries the remainder of the load.

The use of this dolly has not only made the job easier but has cut the transportation cost in half.

Details of construction are shown in the photograph.



DEATH ON THE FIRE LINE

SETH JACKSON

Administrative Officer, U. S. Forest Service, Washington, D. C.

A review of fire fatalities through the years focuses our attention on four major problems.

The greatest man-killer, of course, is the blow-up fire which almost yearly takes its toll. Hundreds have died from this source, if one considers the historic fires of the past, such as Peshtigo. Losses of life are becoming fewer because of organized fire-suppression efforts. Fast initial action with machine-age equipment such as planes, trucks, and tractors, a better understanding of fire behavior, more thorough planning of control strategy, more foremen trained in handling men on fires, has had much to do with the reduction in the number of fire fatalities in recent years. But blow-up fires still constitute the worst potential killer. Much yet remains to be done before the problem is solved.

The second major problem is closely related to my first point. Under extreme emergency conditions, such as occur during blow-up fires, oftentimes men fail to carry out instructions. In trying to work out their own salvation, they become trapped. To overcome this, stressing of crew discipline is a must!

Training to foresee potential events will help. Instructions can then be given before it is necessary to think under pressure. A top foreman gives clear, concise instructions. He tells and demonstrates to his men. He stresses the need of following orders. He checks his men by direct questioning to be sure they understand. He knows them by name; gains their confidence. He follows up to assure compliance. He emphasizes obedience. If and when an emergency comes, he will then be able to control his men and guide them to a previously selected safe location, thus avoiding the crisis.

The third problem crops up almost yearly. Often during fire emergencies, large numbers of men are recruited in a hurry. In the stress of filling the orders for manpower frequently not enough thought is given to their physical condition for the arduous duties ahead. This puts on the fire lines physical incompetents who are actually detrimental to fire suppression. They do not pay their way. They are a drag on the entire organization. All too often, one of these men dies from overexertion.

The remedy is careful screening at the point of hire and again during transportation to the job, in fire camp, and on the fire line itself. The more obvious misfits can be easily screened during the first contact. They may not be properly clothed or shod. They might be in obviously poor physical condition. Direct questioning about such things as hernia, heart, lung trouble, or previous debilitating injuries will weed out many. This process should continue right on out to the line, where in spite of the best intentions, an occasional misfit will arrive.

The fourth problem, tree felling, is common to all forestry or construction work. Last year it was highlighted in fire suppression when four men were killed on national-forest fires alone. Tree felling is a dangerous, unpredictable business. Trees fall or are blown in unexpected directions so often that this possibility should not be overlooked during the best conditions. Wearing hard hats is one safeguard which could well be applied more universally. In addition, it will pay even the most experienced woodsman to plan ahead for the unexpected occurrence. Tricky air currents on fires, and rotten snags with dropping branches or more or less holding wood than anticipated, can cause misfortunes in a few seconds. Injuries can come from lack of a planned escape route, too many men working within the radius of fall of a tree, or simple carelessness.

Probably the thing which is needed most of all in tree felling is lumberjack training which stresses key safety points at each step in the operation.

Looking into the future, we can expect continuing serious injuries and fatalities, accidents from trucks and tractors and mechanical line builders, injuries from plane or helicopter use. Here again, careful training in the use of such equipment and in how to spot hazards will help reduce the number of injuries and fatalities.

At best, fire fighting is hazardous. But it is a job which must be done. We do not want to develop the feeling that because fires are dangerous, we should back away from them without good reason. We must, however, respect the aggravated hazards in fire control and do our best to control them. At the same time, we can instill confidence in our men by letting them know that their welfare is our first consideration when laying out our fire-suppression plans.

WARNING SIGNS FOR FIRE FIGHTERS

A. A. Brown

Chief, Division of Fire Research, U. S. Forest Service

In 1949, 32 men died as a direct result of forest fires on national-forest, State, and private lands. Most of them lost their lives because of extreme fire conditions which resulted in blow-ups. These comments will be confined to these special situations.

Probably it is expecting too much to make fire behavior experts of all fire bosses. Nevertheless, we should go as far as we can in the interest of safety and sound fire strategy.

We need to study the large fire from the point of view of a local weather phenomenon. As soon as sufficient heat and sufficient area, from which heat is rising, have crossed a particular threshold, the fire takes on new potentials in behavior beyond those to be expected by simply extending the dimensions of a small fire. Sometimes we say "it begins to write its own ticket." This is because of the air turbulence which is set up. Similarly, there is good evidence that local atmospheric conditions, beyond the already known effects of humidity and wind, play a big part. This relates to the stability of the air at the location of a fire. It seems reasonable, when an existing atmospheric inversion or ceiling gives way under pressure of a mass of hot air and gases from below, that there is a sudden acceleration in both the rising and descending air currents and a corresponding acceleration in the surface air circulation with effects similar to those of blowing fresh oxygen on a smoldering fire.

In other situations unburned gases seem to accumulate, then explode.

Full analysis of such factors will require the help of competent meteorologists and active participation and close cooperation by both research and administrative groups. This will be essential if we are to make significant new progress in foreseeing blow-up behavior. It can be done.

In the meantime, here are some warning signs to consider when critical situations arise:

Manpower placement and safety

1. Every fire crew boss needs to have a good knowledge of fire behavior if he is to be left on his own responsibility. The alternative is close supervision and explicit safety instructions by an experienced supervising officer.

2. There is always danger in placing men above a large fire and in fighting it from the head down in steep country. Wherever such strategy is necessary, lines of retreat and places of refuge become a critical part of the responsibility of the fire boss.

3. Closely related to No. 2 is the fact that it is always hazardous to attempt to outrun a fire uphill when there is danger of being

trapped. Nearly always there are safer alternatives.

4. Special precautions are needed in assigning men to special duties when they are detached from the main crews or will otherwise be isolated for a time from direct supervision and guidance by an experienced fireman.

5. The danger of being asphyxiated is often overlooked in selecting places of refuge. The bottom of a gulch in the direction of spread may become a chimney flue even though it has no fuel to burn, and most low places directly in the path of the head of the fire have such hazards.

Effects of ground cover

The fire front moves much more rapidly through grass and open cover than through heavy timber. All experienced fire fighters realize this but they often underestimate the contrast in the rate of spread. The fire perimeter can be expected to change from 2 to 10 times as rapidly on the sectors of a fire in that kind of cover. These two—cheatgrass and dry bunchgrass—have extremely high rates of speed in steep country, even if the cover is sparse. It is well to recheck the known ratios between contrasting but intermingled fuel types and to impress them on trainees.

Influence of weather and topography

1. Prevailing wind direction, particularly if the wind is of low velocity, will be modified a great deal by rugged topography.

2. Extremely rugged country is apt to produce erratic behavior in any fire that has gained momentum because of the conflicting air currents that are set up.

3. The mouth of a canyon in rough country is always affected by conflicting air currents. Any fire in its close vicinity is likely to reflect these air currents in its behavior. The head of the fire in such cases may not be the most threatening.

4. To an experienced fire fighter, dust devils—those local whirlwinds of dust—are an ominous sign. Such whirls account for many blow-ups.

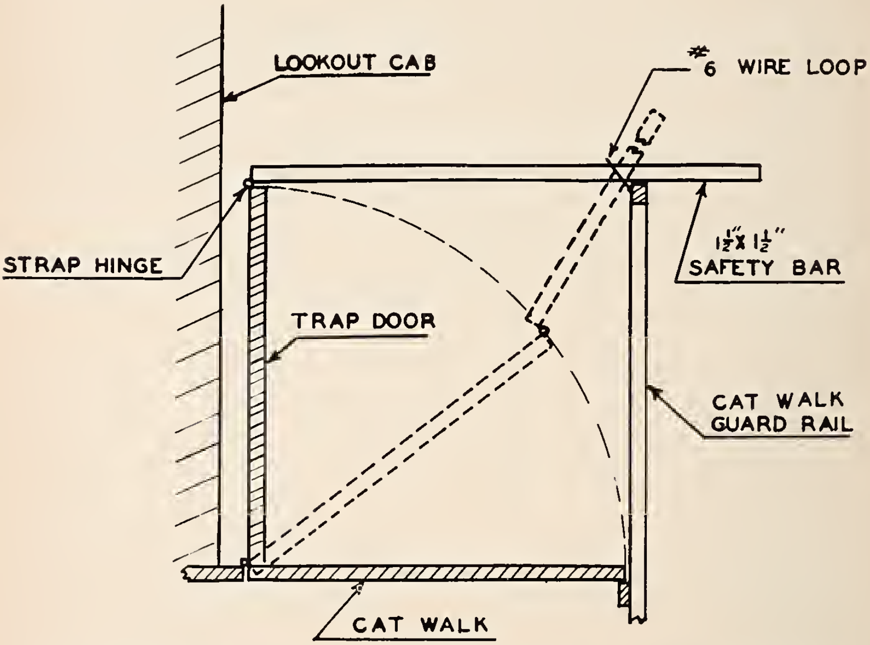
CATWALK SAFETY BAR

H. E. Branagh

District Ranger, Los Padres National Forest

Many of the lookout tower trap doors in California are equipped with safety bars that the lookout man can only hook in place by walking all the way around the catwalk from where the stairs enter it. For that reason, lookout men are prone not to bother putting the safety bar in place when the trap door is open.

The drawing illustrates how a simple, yet effective, automatic safety bar operates. When the door is closed, the piece of lumber 1½ by 1½ by 40 inches, is out of the way by being adjacent to the guardrail. In this position it protrudes 4 inches above the top of the railing, and is held in place by a loop of No. 6 galvanized wire which is bolted to the angle-iron railing.



The lower end of the safety bar is connected to the outer edge of the trap door, and is held in place by means of a strap hinge 1½ inches in width.

Installation of this simple device is positive assurance that the safety bars on lookout towers will always be in their proper place when the trap door is open.

HIGH LIGHTS OF FIRE CONTROL EQUIPMENT DEVELOPMENT PROGRESS IN REGION 1[1]

DIVISION OF FIRE CONTROL

U. S. Forest Service, Washington, D. C.

REGION 1 FIRE LINE TRENCHER

A trial model incorporating information gained from earlier experiments was completed during the winter of 1948–49. This was given a fairly complete test during the spring of 1949. Objectives governing the present project and results obtained from previous pilot model are as follows:

1. Size and weight should be suitable for aerial delivery. The test model weighs 175 pounds and may be packed for aerial delivery in a box approximately 20 by 24 by 36 inches.
2. Units should be self-propelled for ease of operation and to reduce manpower required for suppression use. The test model is powered by 6-horsepower, 4-cycle, air-cooled motor. The arrangement of power drive is such that the machine is powered both forward and reverse through a quick-acting clutch.
3. Performance should be such that a substantial saving in line production may be accomplished. The previous test model has not been used enough to obtain performance in all types of ground conditions. In open types of slope 0 to 30 percent and little or no rock, the machine built 19 chains of acceptable trench in a 15-minute run or 76 chains per working hour. On the most difficult area tried with side slope up to 70 percent and with considerable heavy rock, the trencher built 8 chains of trench in a 15-minute run or 32 chains per working hour. This is about the limit of operation and is very tiring for operator working the machine alone.
4. Climbing ability should be such that the machine will trench up slopes of 60 percent where ground conditions are suitable. The test machine has built trench up a 50 percent slope. In this test there was no rock but considerable light brush. Short runs have been made up 60 percent slope.
5. The machine should operate on steep slide slope. This indicated that the limit for side hill operation is around 70 percent. For the 1950 fiscal year the following was planned: (a) Make final design for production; (b) prepare specifications and shop drawings for production of three units; (c) construct three test units for field service and breakdown testing.

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[1] Extracted from reports to the Chief, U. S. Forest Service.

Progress through January 1.—Drawings are nearly complete and any questionable mechanical application not used in the first model has been tested on a wooden mock-up. Detail drawings of frame, drive arrangement, and handle control have been analyzed for strength by outside engineers. The frame has been shown to a manufacturer for refinement to permit accurate fabrication. Construction of several items such as sprockets and wheels has already been done. It is expected that the three units will be completed in May, and the tests completed in June 1950.

PARACHUTE TEST INSTRUMENT

Since costs prohibit the use of instruments developed by the military an attempt is being made to develop simple low cost instruments for this purpose. To date one instrument has been constructed which appears to have some promise for recording opening and landing shocks. Calibrations have been made with good results. The instruments consist of two large cylinders with pistons having approximately 10 square inches surface. Air from these cylinders is forced into a small one of approximately 1 square inch area. The piston in the small cylinder acts upon a spring which controls the length of line on the recorder measuring opening and landing shock. The test instrument may be weighted for various types of parachute to give load from 50 to 200 pounds.

AIR-CUSHIONED CARGO CONTAINERS

This container is constructed for aerial delivery of miscellaneous cargo. It contains an air chamber to absorb landing shock. Cargo is placed inside a cardboard carton of standard size which is in turn placed in a box. The inner container is allowed to slide inside the box but is cushioned by the air which must escape past the cardboard carton or through escape holes.

LONG-TAILED PARACHUTE

A long-tailed parachute is essentially a standard chute, except that the loading is attached to the chute with a rope approximately 75 feet long. Test drops have indicated near perfect operation in tall timber and the long line has always let the load down to the ground very easily. The chute acts as a brake as the cargo drops to the ground between the trees. Tests indicate that it is much easier to retrieve the chute—many of them without climbing or felling the trees. Too many failures due to breaking the long rope have shown the need for nylon or other high-strength rope. Tests with new high-strength rope should bring successful completion of this item.

PLATFORM FOR DISCHARGING HEAVY CARGO

In order to speed up dropping operations and save flying costs when large planes are used in cargo dropping, an aluminum platform with ball bearing rollers for discharging heavy or bulky cargo or for dumping several small bundles simultaneously is being developed. The present arrangement locks the rollers against the floor of the aircraft while cargo is placed on the ramp. When ready for discharging bundles over the dropping spot, the rear of the platform is raised to free the rollers and slide the cargo out the door. The pilot model is being constructed for use in a C–47 airplane. No tests have been conducted on this item.

FIRE MESS OUTFITS

Changes by manufacturers and developments during World War II have made many items in Forest Service mess outfits obsolete. The 1950 fiscal year project includes:

1. Canvass regions for ideas and suggestions and for information regarding types and sizes of fire mess outfits needed.
2. Develop new methods of packaging suitable for all types of carriers. Investigate new types of lightweight plywood containers.
3. Explore fully paper or other disposable products or other new material which may be suitable.
4. Analyze contents of mess outfits and bring up to date.

Progress to date.—Questionnaires completed by regions have been received and are being analyzed. Information upon available equipment is being catalogued and many samples are being tested and compared. Several sample outfits will be made up for experimental use during the summer of 1950.

Disposable Headlights.—Because of the claim of several western regions that headlight losses on large fires were quite high, it appeared desirable to investigate the possibility of developing an expendable headlight that could be produced at a very low cost. Region 4, United States Forest Service, made up an experimental unit as follows:

The lamp used was of the fixed focus penlite type globe which eliminates the necessity for both a reflector and glass cover. The lamp socket and headpiece assembly was made from tin-plate material with a rubber pad clipped on in a similar manner to that used on the standard Forest Service headlight. A light piece of metal was used to support the socket and to project from the headpiece, allowing for adjusting the angle of the light by simply bending this arm to the angle desired. The head strap was taken from the Forest Service standard headlight. The wire used to make cord was a multistrand plastic covered wire which is soft and pliable. One end of this cord was soldered to the lamp socket, the other end has a two-pronged plug. The battery pack was made of two ordinary flashlight cells connected together in series by piece of wire and wrapped in paper or tape to form a two-cell pack with a socket for two-pronged plug. The connection was made by simply inserting the two-pronged plug into the battery pack socket, thus eliminating the cost of a switch.

This experimental headlight gave a satisfactory light. The total estimated cost of all parts used is approximately $1.54, including one battery pack or $1.24 without battery. A simple economic study made by Region 4 shows that if expendable headlights at $1.24 each were adopted, the annual cost to the Region would be approximately $1,200 more than the present cost with the standard Forest Service light. From this it appears that the cost of the disposable type headlight cannot be more than 60 cents each, if they are to pay their way.

The results of this project show that without a radically new design there is little hope of obtaining a disposable headlight cheap enough to compete with the present Forest Service standard unit. Therefore, our next step should be toward improving and reducing the cost of the standard headlight.—DIVISION OF FIRE CONTROL, *U. S. Forest Service, Washington, D. C.*

LETTER TO A PROFESSOR IN FOREST PROTECTION

[This excellent letter was written in December 1949 by Arthur W. Hartman, assistant regional forester, Division of Fire Control, Region 8, in response to a request from a Professor at a midwestern university who was preparing a course in fire control. Headings have been inserted for the convenience of the reader.—Ed.]

"* * * Forest management in all its phases is a developing, progressive matter. Professional foresters, and the teaching of them, dare not be static. One located at a vantage point for observations must conclude that generally speaking, portions of university training are outdated. Too often new graduates come to work indoctrinated with about the same ideas as were given to me some 35 years ago and which have been passed along with little adjustment to the revelations of experience. * * *

"Fire control is still seen by many at a level of vocational performance or craftsmanship. Our profession is relatively young. So much so that thinking has not emerged generally to where the different levels are defined. For illustration purposes we shall borrow from older professions:

"In construction work we all are familiar with the differences between an architect and the pipe fitter, stone mason and carpenter, and the different levels of training, viewpoints, and thinking each must follow. We are familiar with the variations between a mechanic and a mechanical engineer, the builders of power lines and the electrical engineer. * * *

"A good mechanical engineer should in his early days be given a vocational ground work. He should learn the feel and use of tools, acquire some personal skill in the shaping of metals and gain a working knowledge of shop practices. Thereafter, he moves to the fields of intensive design and applied engineering.

"Any professional forester, if he is going to progress to where he can successfully meet responsibilities for developing and protecting a major high value forest property, must sooner or later learn to see things and think along the same lines as an industrial engineer. As a student, this fact of life should be made plain to him.

"If you will check back over your own school days, field training camps you have attended, and much of the protection literature, I am sure you will find that a pretty good job was done in making you familiar with the working tools. You learned of the tools of fire detection; towers and lookout men; communications and reporting; transportation; project fire camps, how to equip them and feed the help. You no doubt swung a Pulaski tool and built fire lines to acceptable specifications; actually felled dangerous snags, gained an idea of shop practices. * * * At that point one must be classified as learning a trade, developing into a pretty good skilled laborer, or a competent foreman of labor, something of a technician.

"It is above that level where stress and development is needed if young professionals are to gain a concept and understanding of a professional approach to the protection of our timberland resources from fire. Rather than thinking of each function or subject as a thing by itself, good fire control engineering requires an evaluation and blending of economics, silviculture, human relations, laws of nature, logic, soils, and related sciences.

"Proper evaluations, anticipating probable changes, transitions, or events, and planning to be ready to meet most of such things before they are on you—by these, and the quality of their application, is determined whether the battle is won or lost. Of course, no one can be brought to that stage in the classroom. Much experience and many hard knocks are required before the individual comes to a realization of the meaning, value, and place of the many things he is taught.

"Were I to attempt to teach fire control, I think I would first start at the top, give them a professional goal or objective to work toward, outline the finished structure, then of the component members, their places and functions in the whole. Later, as they are led through the subject of working tools and shop practices, as they come up through silviculture, economics or other of the courses, students would be better able to relate them and see them in perspective.

"Certainly they would not be misled into believing that fire control was a matter of just finding fires and extinguishing them. They would gain an understanding that fire is to forestry as diseases are to the human frame. The competence of the medical examiner and diagnostician, the skill of the surgeon or doctor in treatments, eliminates, limits or greatly extends the usefulness of persons. You already know that however ideal the theories of resource management and however good the plans, the results are very much at the mercy of the degree of protection attained.

PRESCRIBED BURNING

"It is good to learn that you are going to give the students an insight into the usable qualities of fire. The woods are full of inhibited men. Southern foresters are more and more adopting the wholesome and, shall we say, scientific approach, segregating facts for what they are and laying them out in the open for nonemotional assessment.

"Unfortunately, you have cited the available literature on prescribed burning. Yes, the use of fire has spread greatly across the South. Quite a few things have been learned or refined. Perhaps it is not as yet timely, but for one reason or another the subject has not been brought up to date in print.

"The Region 8 national forest prescribed burning program for the coming winter will encompass about 200,000 acres. That will include some 25,000 acres of loblolly located both on the Francis Marion in South Carolina and in Texas. The region for a few years had more critical longleaf burning to do than could be handled financially. Loblolly burning was carried on experimentally but on administrative sized blocks. * * *

"Several State forestry organizations have trained their district men to where they now give technical advice to landowners on whether or not to burn and how to burn. Some of the major industrial landowners are using fire when and as they believe such operations are called for.

"Following are some of the things you may not find in print:

"People are like pendulums—they tend to swing from one extreme to the other. One finds the pure fire exclusionist; after learning just enough to know fire can produce some marked benefits (but not enough to appreciate its complexities), this type tends to swing too far over, get 'match happy' and overdo it. That is why students should be let in on the facts and become ingrained with the idea that to burn or not to burn is a matter of cold-blooded analysis and calculation.

"We are not burning in the upland or Piedmont topographic types. We know pretty well the direct physical effects of fire on the various commercial tree species and on the low-grade brush which is encroaching. What the profession has yet to determine are: measures of fire effects on biological content of soils; on water absorbing qualities of soils; and definition of that zone when pine, hardwoods, and brush species are in satisfactory balance.

"Foresters in position to observe wild fire and its effects on loblolly have known for many years that the backing portion of a fire produced no important damage among 4-inch diameter and larger trees at certain seasons and when soils are moist. That observation is being well confirmed by large-scale tests.

"A fairly widespread concept has been that prescribed burning is a form of 'light' burning, done to keep an area from being burned by wildfire. Such a primary use of fire is rare and occurs mainly for the purpose of breaking up or partially insulating major areas having lethal fuel accumulations.

"Most fire use is primarily for silvicultural effects, and on a given area will be accompanied by a considerable spread of years between burns.

"Seedbed preparation and brown-spot control burning have secondary effects of reducing fuel and keeping shrub species controllable.

"Slash and loblolly pine areas in the South have been undergoing a major transition during the last decade. As protection progressed and wildfire burning became less frequent, the various understory species have taken ascendancy over commercial species. Where there have been no fires, such a dense ground cover has developed that reproduction cannot succeed. If that situation is not treated, rather than practicing sustained yield, it will be a matter of gradually harvesting the established stems, then presenting to the public extensive brush fields as the product of professional management.

"Industrial foresters in such areas are plenty scared. They hired out to produce a sustained flow of raw materials for the mills. Cold-eyed directors are beginning to look around and ask questions as to the whereabouts of the future crop. It is a problem that has to be solved, and solved on a business-dollar basis, if the profession is to maintain claims of being expert timberland managers.

"Fire is not the only tool that can be used toward modifying the war between pine and brush for control of an area. One can use bulldozers, poisons, or an ax. In areas of lush growth, the present day costs of such treatments are economically prohibitive. Fire treatments can be effected at around 20 cents per acre.

"This same problem—what species will dominate—is present all the way across this region, and it is gaining momentum. A forestry graduate who goes to this or similar areas, can, if warned of conditions and trained to view the problem with an open mind, be in line to figure out successful performance. The others will be handicapped and less attractive buys to a business wanting results. * * *

RATE OF SPREAD

"There are two types of rate of spread: One deals with increases in fire perimeter; it reflects the size of the line-building job. The other is the rate at which the head or heads of fires travel. It reflects the strategy to be employed to head off the fire. * * * As wind velocity increases, spread rate increases more than proportionately due to spotting well ahead of the flames.

"Because of terrain, or for lack of proper equipment, it is necessary to suppress many fires with manpower. That method is costly, both in direct cash outlay and in producing larger burns on the average with higher fire damage.

FIRE LINE EQUIPMENT

"Various types of motorized fire line equipment have been developed and the spread of their use is rapid. Tractor-plows, bulldozers, motor vehicles with plows, etc. When properly designed for terrain, soil and cover, and used by experienced men, such units can build more and better fire line in an hour than can 25 men. Because a tractor does not tire as a line worker will, their relative advantage over men increases as time passes. A given fire is handled at a lesser over-all cost and the burned acreage is considerably less.

"Students should become aware of powered equipment suppression potentials and be given sufficient insight to realize that present-day developments are only milestones, that they are the ones who will have to devise and adapt to their advantage even better equipment as industrial advances make opportune. * * *

HUMAN RELATIONS

"It would be difficult to overstress to forestry students the decisiveness of human relations over their future success. They may graduate highly polished on scientific theories and facts, but it will be the effectiveness with which they apply and operate them that will be the measure of their value. Important generally, but they should appreciate that in fire control human relations exert at least half of the total influence on results.

"For most timber growing areas the fire problem (both prevention and control) is pretty much a human problem. It is tied into the understanding, thinking, actions, and reactions of great numbers of people from all walks of life, with varied degrees of education, and with different backgrounds and traditions. People cannot be treated as a mass. Properly influencing them will require development of the desire and ability to make penetrating and understanding analysis of them. The forester will have to live among them and work with them. A crucial necessity is that he first succeed in selling himself to a point where he can break through firmly established barriers of clannishness, provincialism, and some prejudice. Only then will he gradually become accepted. Many a young forester seems unaware that he is constantly under observant eyes that measure and weigh his every act. Once he is weighed, for good or bad, people fix and freeze his level of prestige and leadership among them.

"It is more what some might call the little things that count: the sincerity and workmanlike manner with which he goes about each task; the interest in and little considerations he gives to the ordinary fellow he encounters; the willingness to go to a little extra effort to be helpful; retaining his proper position but still being warm and friendly.

"I have seen quite a lot of young foresters make their starts, observed their accomplishments, and noted the influence of various factors over their progress. Far too many have limited their usefulness or broken their careers because of a lack of appreciation and sensitivity to the human side of their jobs. * * *"

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INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

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FORESTRY cannot restore the American heritage of natural resources if the appalling wastage by fire continues. This publication will serve as a channel through which creative developments in management and techniques may be communicated to and from every worker in the field of forest fire control.

Volume 11 Number 4

FIRE CONTROL NOTES

A Quarterly Periodical Devoted to the

TECHNIQUE OF FOREST FIRE CONTROL

The value of this publication will be determined by what Federal, State, and other public agencies, and private companies and individuals contribute out of their experience and research. The types of articles and notes that will be published will deal with fire research or fire control management: Theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, planning, organization, training, fire fighting, methods of reporting, and statistical systems. Space limitations require that articles be kept as brief as the nature of the subject matter will permit.

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D. C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. The printing of this publication has been approved by the Director of the Bureau of the Budget (May 17, 1948).

Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., 15 cents a copy, or by subscription at the rate of 50 cents per year. Postage stamps will not be accepted in payment.

Forest Service, Washington, D. C.

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1950

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"GRASS ROOTS" FIRE PREVENTION

HENRY SIPE

Assistant Supervisor, Cumberland National Forest

The annual fire statistical report indicated the number of forest fires in the United States increased 11 percent in 1949. Census figures for 1950 will likely show the country's population to be growing about 2 million each year. This adds up to an increased fire risk. Although some of the increase is in unprotected areas, debris burning fires on protected areas, for example, increased 48 percent and incendiary fires 33 percent.

Fires can be prevented in two ways: "Shotgun" methods such as the current CFFP campaign posters, news mats, booklets, bookmarks, envelope stickers, etc., or "grass roots on the ground" work by forest officials. There may be those who feel that law enforcement is the final answer to the fire prevention problem; I do not. The following example may illustrate some basic philosophy in fire prevention.

The Sand Hill fire control unit of the Cumberland National Forest in 1946 had an alarming increase in the number of fires. This trend continued in 1947 and 1948, and measures were required to combat the problem. The unit contains 12,400 acres. There are about 110 families scattered fairly well throughout the unit, mostly on submarginal farms. Man-caused fires, excluding railroad fires, that occurred in the unit are as follows:

	Number of fires		
	1946	*1947*	*1948*
Cause:			
Smokers	4	3	3
Campfire	1	0	0
Debris burning	0	1	1
Incendiary	0	1	0
Miscellaneous	5	1	3
Total	10	6	7
Fires per 10,000 acres protected	8. 1	4. 8	5. 6

Since the Cumberland National Forest objective is not more than 0.8 fire per 10,000 acres protected, the occurrence rate was 6 to 10 times too high.

Although only one fire is classed as incendiary, probably more should have been. At least one family was suspected of setting job fires. Another had careless children who might have been causing fires.

In recent years the ranger and his yearlong helpers had not traveled through the area sufficiently to get acquainted with the people. The lookout assigned to the fire tower in the unit was well known, but had a retiring personality and was not in good health.

It was decided to visit as many families and schools as could be reached in 4 days early in 1949. The area had no good roads, so a jeep was used. In February, in company with either the district ranger, a forest guard, or the lookout, I visited 65 families and 4 one-room schools. At the schools we showed colored slides, using the jeep car battery for power. Kodachrome pictures of the pupils were taken. A contact list was made, and keyed by number to a contact map.

On March 18, 1949, a friendly follow-up letter was written to some 70 families in the area and to the school teachers. The letter described why the area was chiefly valuable for timber and gave the growth rate of timber, its financial value, and how the woods could be made to produce good crops of timber. Fire prevention was listed as the first step. The letter closed with a promise of more letters to follow dealing with improvement of the forest.

During the fall of 1949 a similar contact trip was made. A new ranger participated. Fewer family contacts were made, but movies and slides were shown at five of the six schools. At one school, over half the pupils had never seen a movie. Literature was sent to another school, inaccessible even by jeep. A snapshot of pupils at each school was taken. Contact list and map were brought up to date.

On October 6, 1949, a second letter, again friendly and "homey," was written the families, telling about the school contacts, our personnel changes, and expressing appreciation for the lack of fires thus far in 1949. The damage from heavy grazing and the dangers of "lump sum" timber sales by famers to timber operators were described. It was suggested that they plant a few walnuts that fall.

In 1949 only one fire occurred in the area. This was classed as a smoker fire, but was not far from the railroad, and might have been caused by a hobo or railroad employee. This was a very good record, especially since 1949 was much drier than the preceding 2 years.

In February 1950, the district ranger and I visited four schools. A talk was given to the pupils, stressing the damage done by recent floods (10,000 homeless in Kentucky, etc.) and the relation between forests, fires, and floods. The damages done by fire and the ways fire could be prevented were written on the blackboard by the ranger. A mounted photo enlargement (6 by 8 inches) was presented to each school and the negative left with the teacher in case pupils wanted copies. Contact prints were given the teachers individually. Each family represented was supplied literature on forest care, tree planting, and fire prevention. Ten or fifteen residents were contacted enroute. High water prevented travel to the other schools.

On April 6, 1950, a copy of the Forest Newsletter was mailed to each family. This newsletter discussed in an informal way current events over the entire forest. Many of these events were of no special concern to the Sand Hill people, but it served to show that there was a lot of activity on "their" National Forest. Included of course were items such as one about a man they knew paying damages for some fire he had let escape.

The general objective of all this contact work was to get acquainted with the local residents, let them know we had not forgotten them as soon as we were out of sight, learn their problems, and have them learn some of our problems. Fire was not stressed; it was not often mentioned, but it was included in the letters. On the contact sheet for each family was listed items about children, occupation, health, grudges, reputation, anything unusual. Always we tried to note some point that would be an entree on the next visit, or serve to recall the previous meeting. Before arriving at a given farm the contact sheet was reviewed.

How well this work paid is perhaps best shown by the absence of fires in the spring of 1950. Drier fire weather existed than in any year since records were begun in 1937. On March 27, when the rest of the forest had six fires that burned 760 acres (and others getting ready to pop when a heavy rain fell), the Sand Hill unit had no fires. On this day the danger meters went "over the top." In April there was a run of 20 days without rain. On April 24 meters again went over 100. The only fire in the Sand Hill unit this spring escaped from a railroad section crew burning right-of-way.

It is not planned to continue the intensive contact work done during the last year and a half. We will show movies at one school (which we missed) by fording Rockcastle River at low water, and perhaps visit several other schools once this year. Scattered family contacts and small sales will be made, and free fuel permits issued. A copy of each Forest Newsletter will be sent each family ("getting things in the mail makes us feel important!"). Contact work will be tapered off to fit the needs and our available work time. The results in the Sand Hill unit show that fire prevention is mainly a job of "getting acquainted" with the folks who can be a cause of fires.

[The Cumberland National Forest in Kentucky has had rather outstanding success in fire prevention. The average number of man-caused fires for the 5-year period 1936–40 was 315. In 1949, in spite of a more severe burning season, the number was held to 72.—Ed.]

Preventing Discoloration of Paint in Fire Towers.—Over a period of years on this district painting the interior of the cabs on the fire towers has been necessary every 2 or 3 years. During the summer months the sun rays passing through the windows cause the paint to peel on the window sills and to fade in color on the walls and trim. Any furniture in the direct rays of the sun is affected to the same extent.

In the spring of 1948 the interior of two towers were painted at the same time and with the same type of paint. During the summer season when the towers are closed the windows of one tower were given a heavy coating of Bon-Ami on the inside of the glass while the windows of the other tower were left uncoated. The paint on the tower treated with Bon-Ami after 2 years is as bright as when it was applied, while the tower not treated is due for another painting by the spring of 1951.

Since one of the first duties of a lookout when opening the tower at the beginning of the season is to clean the windows, it is a simple matter for him to wipe the Bon-Ami from the windows in the process of cleaning.—FRED M. WEAVER, *forestry aid, Jefferson National Forest.*

DEBRIS BURNING ON THE OUACHITA

G. H. Stradt

Assistant Forest Supervisor, Ouachita National Forest

Every spring hundreds of brush burning smokes can be observed throughout the Ouachita Forest area, which contains over 2 million acres under protection in Arkansas and Oklahoma. It is the time of the year when fields, brush, and trash are burned in preparation for spring planting, a practice of long standing. Analysis of fire statistics points out that debris burning fires are more apt to escape during the period of February 16 to April 15, depending somewhat on whether spring is early or late, although burning begins soon after January 1, and continues through April. The "escape" period includes that of the highest fire danger created by cured vegetation and strong, switching March winds.

Legislation in both States requires reporting proposed burning in organized fire protection areas, as well as penalties for permitting fire to escape to other ownerships. Law enforcement is one method of approach, but experience over the past 10 years indicates other methods may be better.

Table 1 gives a comparison of total fires classified as lightning and man-caused, and the relation between debris and man-caused fires for calendar years 1940–49.

TABLE 1.—*Lightning and man-caused fires, and relation of debris to man-caused fires, 1940–49*

Year	Total fires	Lightning fires	Man-caused fires	Debris fires	Relation of debris to man-caused fires
	Number	*Number*	*Number*	*Number*	*Percent*
1940	167	47	120	30	25. 0
1941	120	47	73	15	20. 5
1942	130	34	96	13	13. 5
1943	369	114	255	35	13. 7
1944	180	116	64	9	14. 0
1945	67	22	45	5	11. 0
1946	165	36	129	27	20. 9
1947	245	71	174	22	12. 6
1948	191	84	107	16	15. 0
1949	111	23	88	13	14. 8
Average	175	59	116	19	16. 3

The highest number of fires during the 10-year period was recorded in 1943, when five or more occurred every month during the year. In 1945, an unusually wet year, the forest area had an all-time low in number of fires and acres burned during its 40 years of existence under organized protection. The low number of debris fires is attributed to decreased farm activities, due to armed service and defense job movement, together with low hazard conditions. In 1946 the movement was reversed with an accompanying increase in debris fires.

To reduce the number of debris fires, which during 1946 again exceeded 20 percent of the man-caused fires, a forest-wide campaign was developed, to be effective with calendar year 1947 and continue thereafter with other phases of the prevention program. This campaign, which strives principally for on-the-ground contact, contains the following stipulations:

1. Continue thorough investigation of fires, with State or Federal law enforcement.
2. Distribute brush burner cards for reporting proposed authorized burning.
3. Maintain record of all brush burner contacts by name and location, and give brief account of conversation for future reference.
4. Contact all new families and acquaint them with FIRE, as well as all applicable State and Federal forest regulations. Also recontact old families when in their vicinity. Discourage burning by suggesting other means of disposal. If they intend to burn, go over the problem on the ground and encourage burning after 4 p. m., confined to small areas on wet, damp, and low-danger days before February 15, with sufficient control line, manpower, and suitable equipment.
5. Prepare news releases as a reminder of low and high fire danger periods. Supervisor's office to prepare articles as a series and release by scheduled date.

The program has resulted in a substantial reduction in number of debris fires over the past 3 years (a reduction of 18 percent in 1947 as compared with 1946, and 52 percent in 1949). Authorized burners are taking suggested precautions by burning smaller areas and attempting to use natural barriers or previously constructed lines. In addition, an increasing number of brush fires were observed during wet and damp days or late in the afternoon. A good detection and dispatcher system, together with residents reporting proposed burning, has also resulted in fewer false alarm runs.

During the spring of 1950 an additional item of prevention was added to the campaign. In cooperation with Hot Springs National Park and Radio Station KWFC, a trial system of reporting class of fire danger and degree of hazard and risk for guidance of brush burners was initiated. This system is not new, but it had not been used in this area before. This spring the records show continued progress in controlling debris burning. Of 87 man-caused fires, only 11 (13 percent) were from debris burning.

An example of needed contact was noted during the spring of 1948 when a resident living outside the Ouachita National Forest and south of the mountainous terrain, attempted authorized burning, without help or equipment, on some of his land located on a south slope within the forest boundary. He selected a day in March during a class 4 fire danger build-up. The fire quickly escaped and burned over 100 acres before suppression forces could control the spread. This individual was not accustomed to fire behavior in the mountains, even though he had practiced burning on flat and rolling terrain for many years. In this case a previous contact could have prevented a reportable fire and follow-up conviction in court.

The campaign will be continued not only from the standpoint of the debris burning problem, but also on the basis of its favorable effect on the entire fire prevention problem.

MULLIN DOZER TOOTH SHANK AIDS IN SLASH DISPOSAL AND FIRE LINE CONSTRUCTION

H. A. Mullin

Equipment Engineer, Region 3, U. S. Forest Service

Fire lines can now be constructed in rocky formations by using digging points attached to a specially built dozer tooth shank developed and tested by the United States Forest Service in the Southwestern Region. A tapered box welded through the cross-section of moldboard of any type dozer receives the tooth shank (fig. 1). The box is designed with a taper to accommodate a wedge that holds the tooth shank tight in the box. Four tooth shanks are considered adequate for most work.

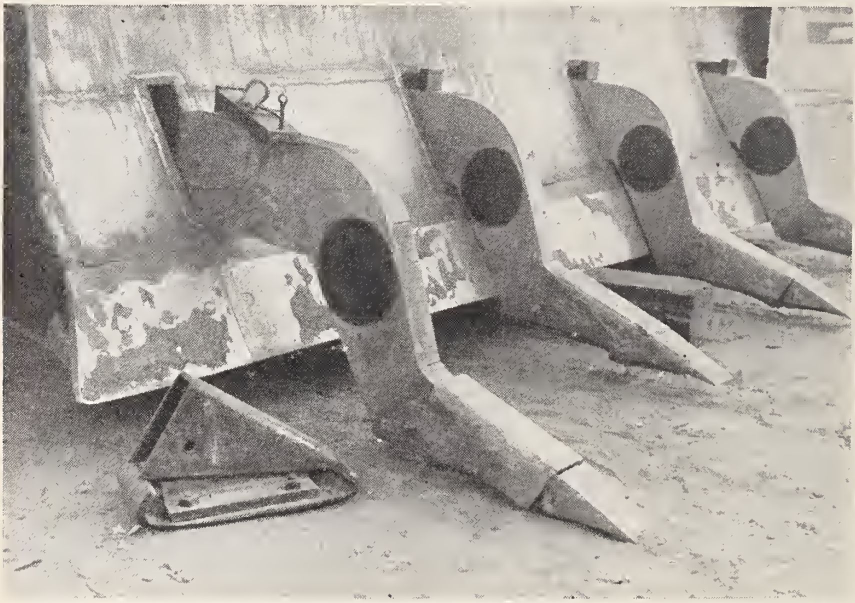


Figure 1.—Tooth shank installation, digging points, brush shoe, and method of installation in a bulldozer.

Two styles of digging points were tested. A third type originated by the author has been designed, but not thoroughly tested yet. It is hoped that the new type will contain features the others do not have.

Figure 2 shows the installation of skid shoes used to float the moldboard 4 or 5 inches above the ground surface as an aid in bunching heavy slash after logging. Skid plates are reversible to compensate for wear. The skid shoe design requires a 1-inch incidence and has a blunt end to avoid penetration into the soil. The weight of the moldboard is carried on the heel of the shoe. This feature offers a means of packing or solidifying the soil while the shoe is skidding over the surface of the ground. The tooth shank protruding out in front of the moldboard reduces the danger of logs skidding on the moldboard when logs are pushed endwise. Large logs can be "floated" ahead of the dozer if the brush shoes are pushed under the log.

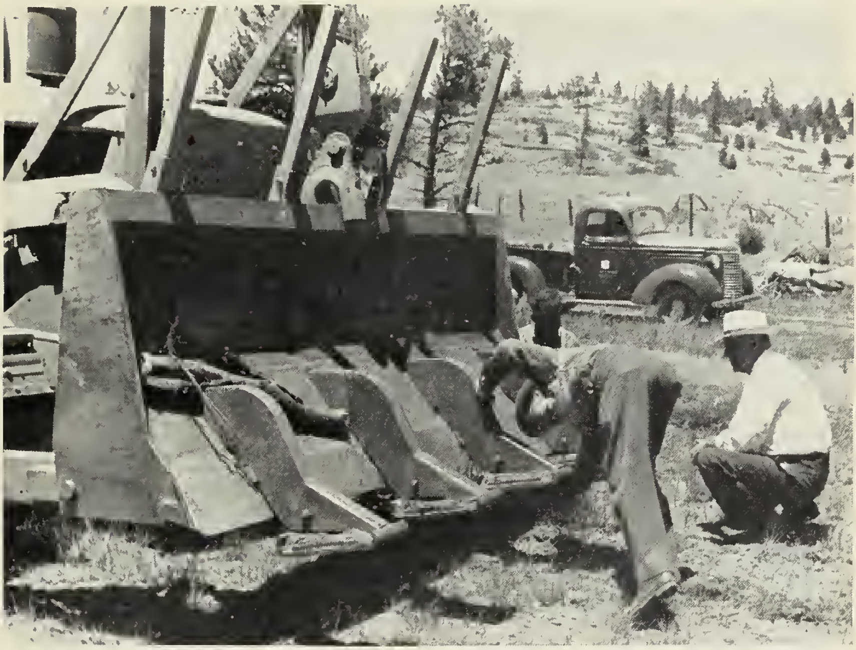


FIGURE 2.—Typical (original) installation of brush shoes on dozer tooth shanks.

Digging points may be installed on the shanks by removing the brush shoes. This requires removing one bolt in each shoe. The same bolt is used to secure the digging point to the tooth shank.

It is estimated that dozer efficiency is increased from 30 to 100 percent depending upon the type of earth formation. Digging ability is made possible by the angle of the digging point. The top of the digging point angle in relation to the ground works on the principle of the wedge, to give mechanical advantage, less friction. The lifting force of the teeth when used as a wedge is three to four times the pushing force. This accounts for the rapid penetration of the moldboard in extremely hard or rocky formations that straight or angle blades would not penetrate.

The tooth shanks and digging points act for the dozer moldboard in the same manner as the teeth on a shovel bucket: the teeth penetrate and break up the soil or loosen the rocks before the moldboard strikes.

Sharp digging points are desirable on all digging tools. If sharp points are maintained penetration into the soil and roots can be done with a minimum of power. Working conditions will dictate the best digging point angle. Operators should keep in mind that the greatest mechanical advantage is obtained with the smallest tooth angle.

The tooth shanks can be installed on any dozer. Teeth have been spaced approximately 2½ feet apart on 10-foot moldboards.

It is recommended that for the greatest efficiency installations be made on tiltdozers. This makes it possible to adjust the digging point angle to match working conditions as well as compensate for tooth wear.

Sketches in figure 3 are presented to give the reader a third dimensional view not obtainable with photographs.

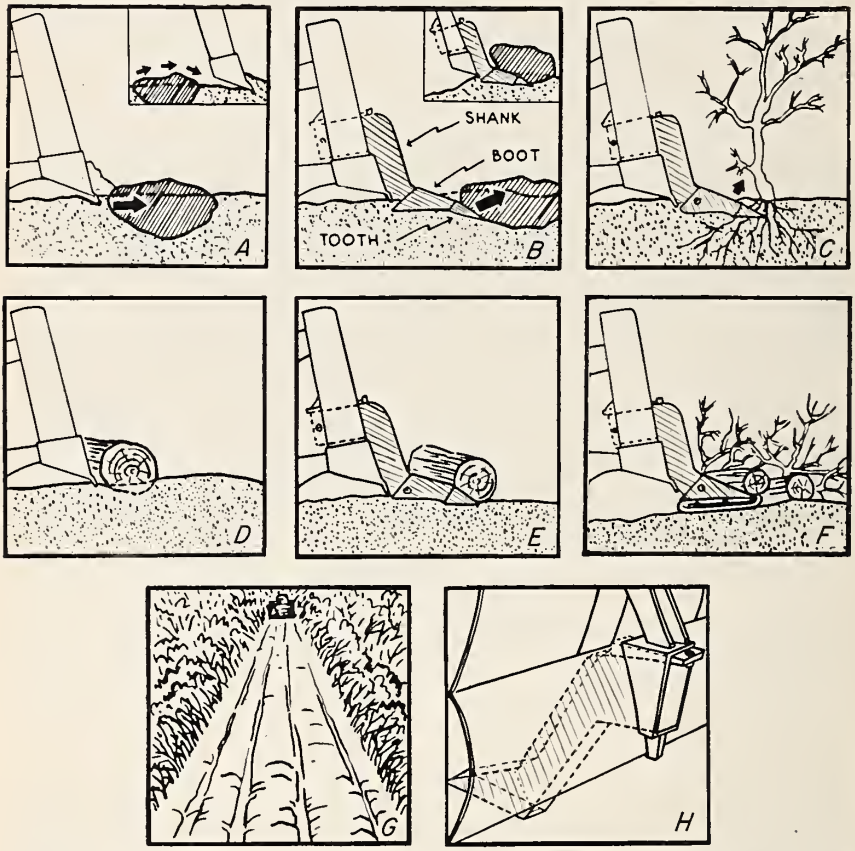


Figure 3.—*A*. Action of a conventional dozer moldboard striking a rock; arrow indicates the movement of the rock in the event the cutting edge does not slip over the rock. The conventional moldboard usually travels over the rock. *B*, Digging tooth being forced under the rock and applying lifting action from its power as a wedge. *C*, Action of a dozer tooth digging point directed at the roots of brush or small trees. *D*, Conventional dozer pushing a log partially imbedded in the ground. *E*, Lifting action takes place when log is pushed by dozer equipped with teeth. *F*, Brush shoe floating the dozer blade and picking up heavy fuels. *G*, Fire line construction or road right-of-way clearing in dense brush by dozer with digging teeth. *H*, Installation of a dozer tooth shank as seen from the back of a dozer moldboard.

This tool is not a scarifier. It penetrates like a wedge, lifts rocks and small trees. In hard ground the tooth point pulls the moldboard cutting edge into the ground making it possible to get a full load with a minimum of tractor travel. This means more production in shorter time.

Cost of the installation complete, without digging points, for a D7 will be $450 to $550 depending on the initial cost of the shanks and facilities for welding. The cost of this equipment has been found through experiment and practical usage to be quite nominal in proportion to time saved and production increase, gaged over a short period of time.

Use of Electric Wind Vane by a Coastal Plain Ranger District.—On the Chickasawhay Ranger District of the DeSoto National Forest, the electric wind vane, which can be read down to units of 22½° of direction, has an important place in fire suppression and prescribed burning work. The district is relatively level and there are no mountains to influence the air currents. Fuel has a high rate of spread index.

Information on accurate wind direction and its direction behavior is an essential aid to the dispatcher in determining the number of crews and men to be dispatched to a given fire where advantage can be taken of natural firebreaks, old wild fire burned areas, and prescribed burn areas. This is especially necessary when a number of fires are going at the same time.

The fire crew foreman normally makes some preliminary tactical plans as he travels to a fire. The essential information on wind direction given him by the dispatcher aids him in organizing his preliminary suppression plans, and when on the fire, in carrying out his suppression work. During the life of the fire, wind direction and behavior changes are reported to him on the fire line.

During periods of prescribed burning work, an analysis of weather conditions at work time in the morning will usually indicate the possibilities of carrying on prescribed burning that day. Because of the relatively few days when prescribed burning can be successfully carried on, full advantage must be taken of every such day. The electric wind vane is sensitive enought to indicate the wind direction and something of its behavior for the day to a degree not otherwise interpretable. These early morning interpretations are essential for administrative assignment of the prescribed burning crews to other work if prescribed burning cannot be carried on that day. They also indicate times when special attention may be necessary on those areas prescribed burned the day before, and which were allowed to burn into the night.

Experience has shown that on this district the most desirable and dependable wind for winter prescribed burning is the north wind that follows a good winter rain. It lasts for a period of up to about 4 days, with the final wind shift, usually clockwise, at night.

Occasionally this north wind begins to shift in the middle of the day and as early as the second day after the rain. The first indications are slight shifts not readily interpreted on the ground, but definitely noticeable on the dial of the electric wind vane. When the fire dispatcher interprets the slight shift as an indication of a wind shift, he notifies the prescribed burning crews by radio. The crew foremen can then plan for suppressing the prescribed burning if it should become necessary, and thereby keep burning damage to a minimum.

In late summer and early fall when prescribed burning for seed-bed preparation and control of undesirable species is being conducted, the winds are not nearly as dependable in direction and behavior as the winter winds. Wind direction varies considerably throughout the day and damage to tree growth is more easily inflicted. Therefore, during this period the prescribed burning crews must be accurately informed about the wind direction and its behavior throughout the day.

A satisfactory electric wind vane can be purchased for as little as $25 to $35. It is a good investment for a coastal plain ranger district.—FRED G. AMES, *forester, Division of Fire Control, Region 8, United States Forest Service.*

USE OF AIRCRAFT IN CONTROL OF LIGHTNING FIRES ON BLACK HILLS NATIONAL FOREST

John P. Burke

Staff Assistant (Fire Control), Black Hills National Forest

A review of the last five fire seasons for the Black Hills National Forest and surrounding protection zone revealed that 74 percent of the fires were lightning caused. Experience has shown that, with sever burning conditions, most lightning fires in the Black Hills will put up at least a small smoke immediately after the strike. The object is to take action on these fires before they grow to critical size or shrink in the rain to become tricky sleepers. Quick action also leads to control of a fire while it is still burning only on the surface of the duff, thereby reducing mop-up time and expense. Unless prompt action is taken on fires after (or during) severe electric storms, their number and growing size can cause the suppression job to snowball to unmanageable proportions. It is in the detection and suppression of these fires that the use of aircraft has become important.

Aerial detection supplements lookout detection on the Black Hills National Forest, but will probably never supplant it. The lookouts report approaching electric storms to the supervisor's office, and maintain a record of the path of the storms and of individual strikes. If the fire danger justifies such action, a plane is sent out in time to follow the storm onto the forest, and it stays on the job as long after the storm has passed as conditions warrant. When forest fuels have had a chance to dry sufficiently to bring out sleepers, the plane is again used. As soon as a flight is scheduled, all lookouts are informed of the course to be flown and are thus alerted to exchange information with the aircraft observer by radio.

When the observer sights a smoke he reports it, immediately if possible, to the nearest lookout, suppression crew, or ranger. Merely being able to see the fire from the air, however, is not enough. The observer must be able to gage the fuel type, slope, size and behavior of the fire, and other important factors, so that he has a basis for determining adequate manpower and equipment. When the fire is in a location not positively identifiable by description, the observer gives instructions to the crew to drive to a known point as near to the fire as possible. While the crew is traveling to this point the plane may continue the patrol, or may be used for picking out a route to the fire. The observer's judgment from the air of the negotiability of roads is very important. Having reached the appointed place, the crew is directed to the fire by instructions over the radio from the aircraft observer.

In rolling country where the hilltops are timbered and no vantage points are available to the suppression crews, much time can be lost in reaching the fire. Frequently a slight breeze will carry the smoke into the timber or behind a hill, so that the crew can pass very close to the fire without locating it. If the observer can follow the crew from the air, he can stop them at the proper point.

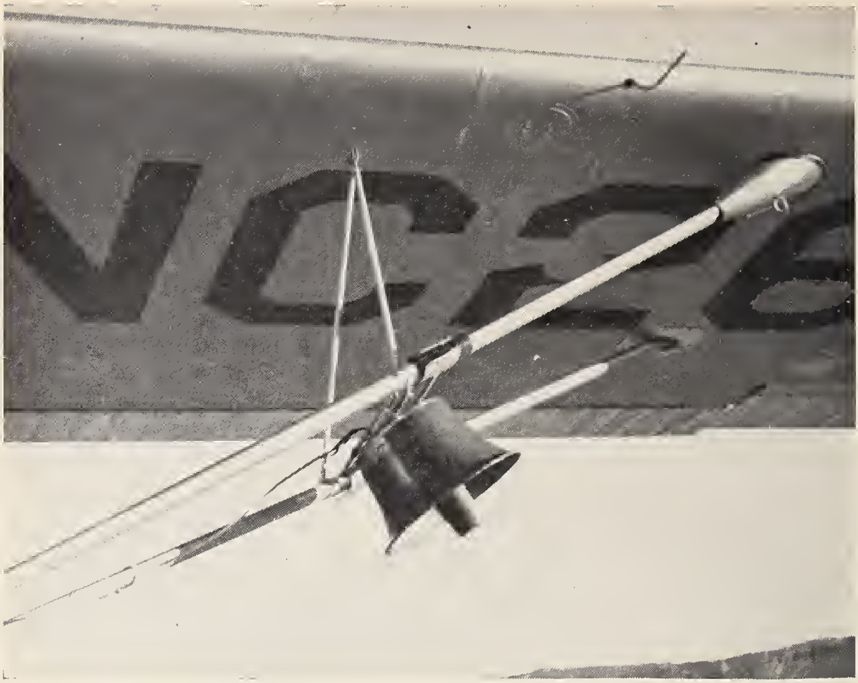
On old, narrow roads through heavy timber it is difficult to locate a pickup truck, and extremely difficult to follow the progress of a man on foot. During daylight hours in clear weather any reflecting surface may be used to reflect a beam of light from the sun to the plane. Signaling mirrors with aiming devices and instructions, salvaged from armed forces rescue kits, are effective for 10 miles or more. The aiming device is especially helpful in hitting a small target such as a plane at a distance.

If the fire is too far from a Forest Service crew for quick first attack, the lookout dispatcher may telephone the nearest cooperator. However, most local residents do not have telephones. The plane, therefore, was equipped with a loud-speaker so that the observer could request the needed assistance from the nearest cooperator, while the plane circled the ranch house or sawmill. The cooperator is informed of the location of the fire, its size, kind of fuel, and the size of crew and kind of tools needed. The plane, by means of instructions through the loud-speaker, leads the cooperator to the fire. Arm signals are used by the man on the ground to answer questions by the observer, who must anticipate the other's message in order to ask the questions. If more help is needed, the observer requests it by radio through the district organization or by loud-speaker from another cooperator. In any event, the cooperator is thanked, and informed that the fire is being reported to the ranger.

A high-wing monoplane with a low engine cowl is in our experience the most suitable type of aircraft. It provides excellent visibility, both to the sides and ahead; it carries ample fuel for 4 hours in the air; and air speed may be varied from 70 to 140 miles per hour. A four-place plane provides ample room for the use of radio, maps and other paraphernalia, while a smaller plane is noticeably crowded and reduces efficiency. A shelf over the baggage compartment of the four-place plane provides mounting space for two 25-watt amplifiers weighing a total of 32 pounds. The left wing struts support a compact speaker, as shown in the photograph.

The walkie-talkie radiophone, type SF, is effective for temporary use in the plane. Fitted with an adapter plug and swivel lug attached to an insulated wire antenna, the set can be turned on and off, as with the original antenna, by screwing the plug in or out. The fine wire antenna is extended out the window, which may be closed on it without damage to the window. The outer end of the antenna is taped to the wing strut about 14 inches below the wing, with the tension sufficient to hold the wire fairly straight and with sufficient length inside the plane to permit manipulation of the set. The SF radiophone should be provided with separate microphone and headphone on cords so that the case containing chassis and batteries need not be held by the operator. A kit providing the necessary parts is being supplied for the 1950 season.

The present technique results in considerable saving particularly in the control of lightning fires. Because of it no great expansion of the present lookout system is contemplated. Consistently quicker detection of lightning fires, more positive first attack and quicker control,



The sturdy, compact speaker mounted on the left wing struts does not noticeably alter the flight characteristics of the plane.

and a smaller mop-up job result in savings which amount to several times the cost of plane hire. The added safety in controlling fires while they are still small is probably the greatest advantage, though it is hard to prove by statistics on the fires that don't get away.

[Aircraft operators must obtain CAA approval on each installation of equipment of the character described in this article. Additional information can be secured from the Forest Supervisor, Black Hills National Forest, Deadwood, S. Dak.]

CARGO PARACHUTE EXPERIMENTS

FIRE CONTROL EQUIPMENT DEVELOPMENT PROJECT

Region 1, U. S. Forest Service

CLUSTER PARACHUTE

The cluster parachute consists of three standard 22-foot rayon cargo chutes attached to a common riser which carries the load (fig. 1). The distance from perimeter of each parachute to the container or load is 40 feet. Weight of the complete unit, packed in special container, is 66 pounds.

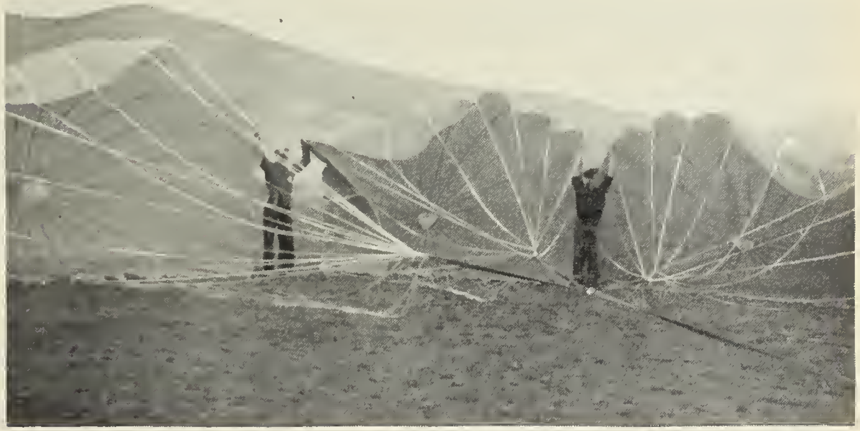


FIGURE 1.—Cluster parachute for loads up to 600 pounds. Note method of attachment to common riser.

The cluster parachute was devised for carrying heavy loads of water, fuel oil, or equipment. Although total weight (66 pounds) seems considerable, it is less than that of three parachutes packed in separate containers. Advantage of the large parachutes are savings in flying time, less scattering of loads, and means of dropping equipment weighing over 200 pounds. When more than one conventional parachute is attached at the load, the parachutes repel each other, causing a high rate of descent and an increase in the number of malfunctions due to one canopy opening before the other.

Test drops made to date have been successful from a standpoint of damage to cargo but rates of descent are somewhat faster than other special chutes (multiple parachute). There was also a tendency of this parachute to oscillate slightly more than other types tested.

Conclusions were that this parachute arrangement can be improved to obtain a slower rate of descent and perhaps less tendency to oscillate. Because of the tests it is not recommended for general use at this time.

MULTIPLE-UNIT PARACHUTE

This project included development and test of a multiple-unit parachute for use with loads from 400 to 600 pounds. Development of a roller platform for heavy cargo and the increasing demand to drop heavy loads of water, fuel oil, or equipment has created a need for this type of parachute or methods of using standard freight chutes in clusters or pairs. Test drops of equipment, supported by two or more standard chutes attached to the load at a central point, show that the escape of air at the perimeter causes the chutes to repel each other, resulting in a faster rate of descent and contributing toward oscillation in rough air. This was also the case, but to a smaller degree, with the parachutes attached to a common riser.

The multiple-unit chute was constructed of three 22-foot rayon cargo chutes sewn together at the perimeter to form one large triangular canopy. The resulting hole between the parachutes was enclosed by a six-gore, conical chute sewn to the main canopies with zigzag stitching. The length of load lines was varied to allow the canopy to ride flat, and the lines were attached to a single riser of double thickness webbing. The load is attached to this riser.

The weight of this giant parachute is 71 pounds with container. Standard rayon cargo chutes weigh 24 pounds each, complete with containers.

Drop tests of the parachute, with a 526-pound load, indicate very good performance. Rate of descent averaged 23.5 feet per second. There was very little oscillation even in fairly rough air. Opening required 2½ seconds, which is fast enough for low-level dropping for greater accuracy.

Figure 2 shows multiple-unit parachute as packed for use with heavy loads. Single large container is easier to handle in plane than three individual parachutes.

This parachute has a definite place and, of the three different types or kinds tested, gives the best all-round performance on heavy loads. It requires special construction and it is not believed that many of the units should be kept on hand except for special jobs.

BASEBALL PARACHUTE

Baseball parachutes are obtained from Army surplus and available for further orders. The parachute is bias constructed and formed, and has a muslin canopy with braided rayon lines. It differs from the conventional flat type canopy in that it assumes a half-round shape when fully inflated (fig. 3). There is no apex vent. The unit is machine-packed in a square, plastic-impregnated fabric container, the upper half of which is lost when the chute is pulled out. Repacking of the chute in the same type of container is impractical although many of them could be salvaged and repacked into a canvas sock, similar to the present standard cargo chute container but of a larger size.

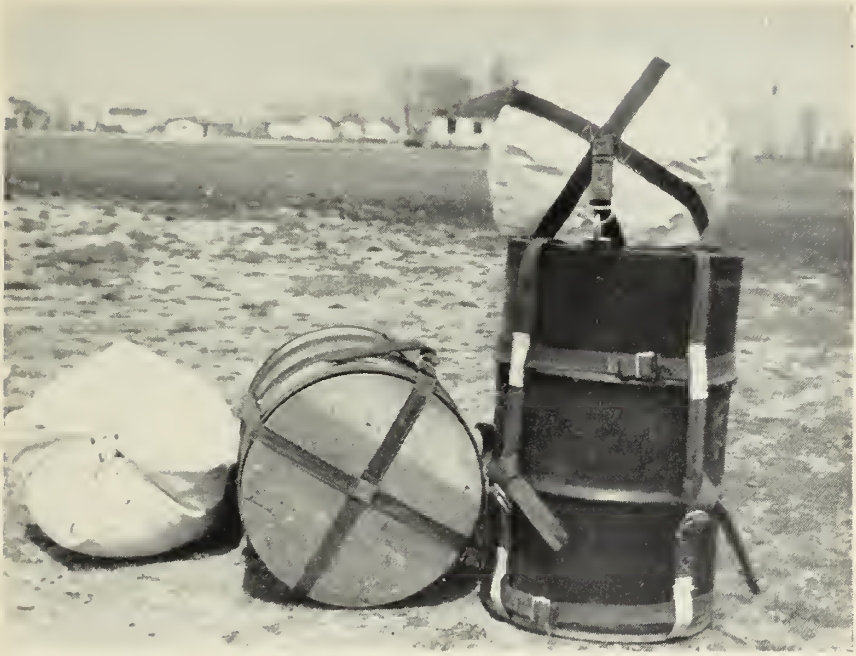


FIGURE 2.—Multiple-unit parachute in container shown with test loads in heavy drums, weighing 526 pounds.

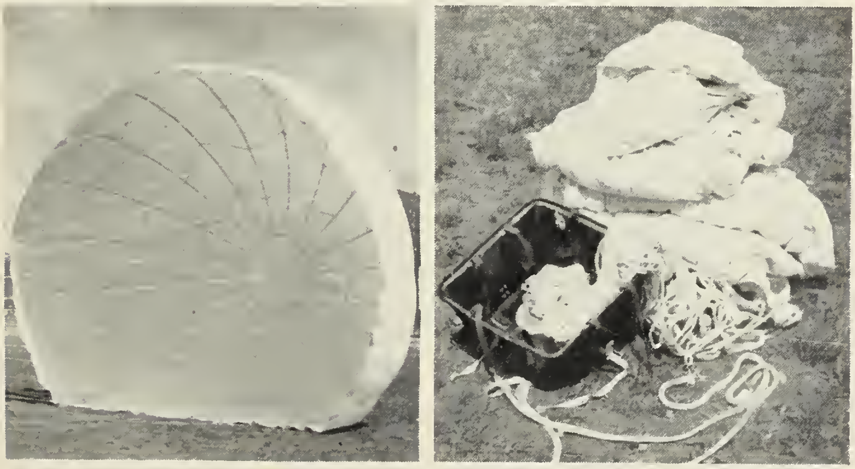


FIGURE 3.—Baseball parachute: *Left*, Extended. Note shape and construction. *Right*, after use. Note bulk of material; half of its container is shown.

The unit, as received and described above, weighs 35 pounds. The diameter of the baseball parachute is given as 20 feet, but because of its formed construction it has a greater surface area than the conventional 24-foot canopy.

Test drops were very satisfactory. Average opening time was 1½ seconds; average rate of descent, 23½ feet per second with 150-pound load and airspeed of 110 miles per hour. Little or no oscillation and very light landing shock were experienced.

We do not recommend loads over 150 pounds or airspeeds over 110 miles per hour, as opening shock is rather severe (indicated by broken line on one drop). The weight and bulkiness, when repacked into canvas containers, is a disadvantage for smoke jumper use or when several packages must be carried on one trip.

ENLARGED APEX VENT

This project was undertaken to reduce the opening shock of parachutes, used with the long rope attachment, for timber drops. It is believed by reducing the opening shock that a smaller and less expensive long rope may be used. At present one-half-inch rope, preferably nylon, is needed for dropping cargo in heavy timber.

A standard cargo chute was modified to provide a 35-inch-diameter vent in the apex. An 18-inch-diameter bungee ring was installed to close the vent after the opening shock. Modification costs totaled $10.46 for test parachutes. This cost would be reduced considerably if a number of parachutes were modified.

In test drops the parachutes equipped with the apex vent functioned perfectly. Rates of descent were normal. In one drop the long rope (three-eighth-inch nylon) broke in two places but this was an old rope that apparently had lost the elasticity that gives it maximum strength. Also, the cargo was discharged at 110 miles per hour, which is well above the speeds normally used.

We believe it is possible to reduce the labor and material required to modify the standard chute by incorporating the bungee ring directly into the apex of the chute. This is to be tried.

UMBRELLA PARACHUTE

The umbrella parachute is a modification of the standard cargo chute designed to reduce rate of descent and oscillation.

Modification of the standard chute consists of air vents, arranged in a circular pattern, around the upper third of the canopy. The vents are cut across the panels of the parachute and material hemmed on each edge for strength. These vents allow the escape of surplus air which normally is lost around the perimeter and through the apex vent. By "skirting" these vents, additional lift is created over the skirts and the top of the canopy (fig. 4). Skirts are positioned by secondary lines attached to the main lines of the parachute. It is believed that the modification of a number of parachutes may be accomplished when damaged chutes are repaired. The additional material needed for the skirts may be secured from chutes damaged beyond economical repair.

Tests of this chute indicate that further study is needed to perfect the modification, although rates of descent appear to be slower than those of conventional parachutes and there is a noticeable decrease in the oscillation in rough air. Average rate of descent of the umbrella parachute on test drops made to date is 22 feet per second with 150-pound load.

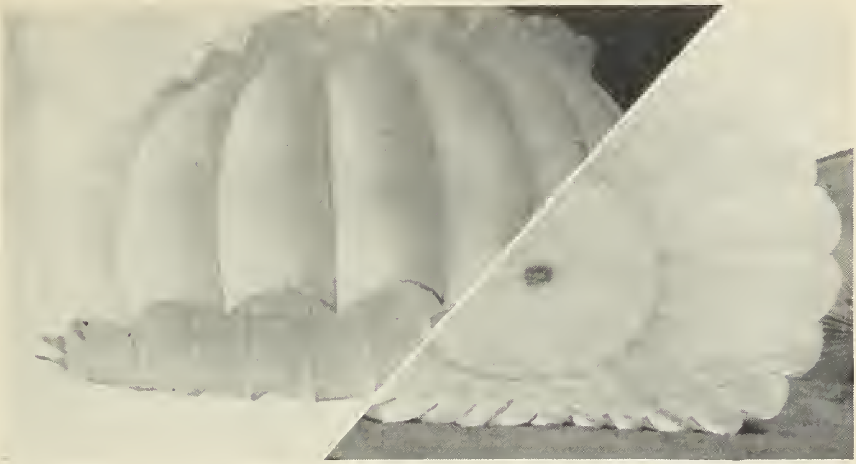


FIGURE 4.—Umbrella parachute: *Left*, skirted lobes arranged in the canopy; *right*, arrangement of vents in upper third of the canopy.

12-FOOT RAYON PARACHUTE

This region recently purchased 200 12-foot orange rayon parachutes (Army surplus) for use with light cargo. Performance tests were made and the record established in case others become available or we receive requests for information concerning this type from other regions.

The parachutes will be repacked in small canvas containers for use in this region. Weight is approximately 1 pound. Initial cost of the parachutes was $2 each.

In general, these small chutes are suitable for loads up to 50 pounds. Fragile loads, or water in 5-gallon cases, should not weigh over 32 pounds. Opening characteristics were superior to the coffin-silk flare chutes used extensively in this region for smoke-jumper packs, light loads of subsistence or water, and other equipment.

ROLLER PLATFORM FOR DISCHARGING AIR CARGO

Fire Control Equipment Development Project

Region 1, U. S. Forest Service

The region has been using two Douglas C–47 airplanes extensively for aerial freight delivery and smoke-jumping activities. Cost per hour is but little more than that of the Fords and Travelairs because of the faster cruising speed. The big planes do require, however, more maneuvering time for dropping cargo in difficult areas. The roller platform was built to enable freight droppers to discharge heavy cargo or multiple bundles quickly and easily at the proper time. The advantages are: (1) Reduction of flying costs; (2) less scattering of bundles on ground; (3) greater dropping accuracy; (4) ease of handling heavy cargo such as a barrel of fuel oil; (5) safety of operation.

The platform frame is constructed of welded, square steel tubing arranged to support ball-bearing rollers made of aluminum tubing. Twelve rollers were used in this model but drawings and specifications are being revised to include two additional rollers. These additional rollers will be installed in the two outside panels in line with the second roller of the center panel. This will provide five rollers on the outside edge instead of the four shown in figure 1.

A sheet of aluminum is riveted to the framework on the upper side and slots cut for the rollers to work in. The rollers extend approximately one-fourth inch above the platform. Pins on the front corners position the platform in the door of the plane.

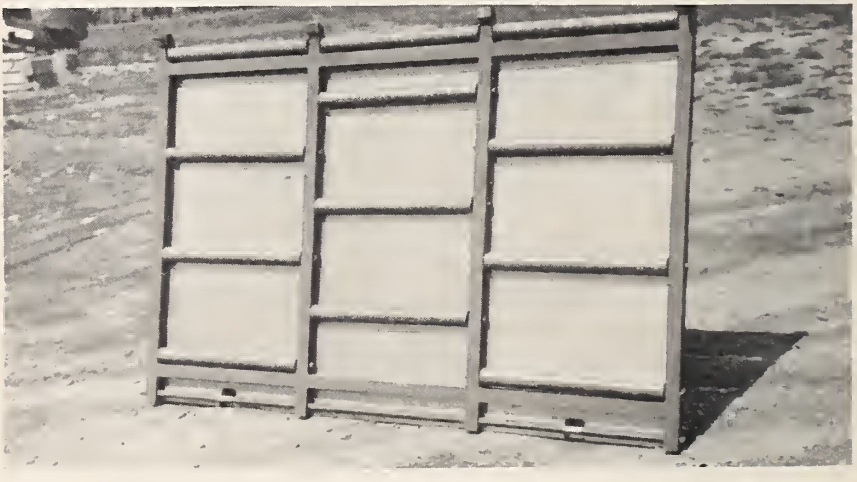


Figure 1.—Bottom view of platform showing construction details. Pin in front corner is for positioning platform in door of plane.

The roller platform has performed successfully in all test drops. We have discharged loads weighing 1,196 pounds with one man only on the lifting bar. With multiple bundles, the practice is to space them as far apart as possible and following each other as they leave the door. Parachutes fouled each other temporarily in opening on one test, but loads were undamaged on landing.

Total cost of the development was $353. Similar roller platforms may be constructed for approximately $200 for labor and materials, with smaller platforms costing correspondingly less.

As a result of tests made on this unit, we plan to construct a roller platform for use in the Ford and Travelair airplanes. Although smaller in capacity, the roller platform in these planes will discharge cargo faster and easier than present methods.

The lifting device consists of tubular handles, with rollers made of ball-bearings, and offset arms slotted to engage a bar in the rear of the framework (fig. 2). Not shown in the picture is a rubber pad which is installed between the floor of the plane and the platform. This rubber pad engages the rollers when the platform is lowered to prevent the rolls turning while the platform is being loaded for a drop, or until the platform is raised to discharge the cargo. This is an important safety precaution and makes it easier to load the platform in flight.

When the platform is raised, the rolls are free to turn, and the incline is sufficient to cause loads to roll by gravity. A sheet of heavy cardboard under odd-shaped or roped bundles will allow them to roll out easily.

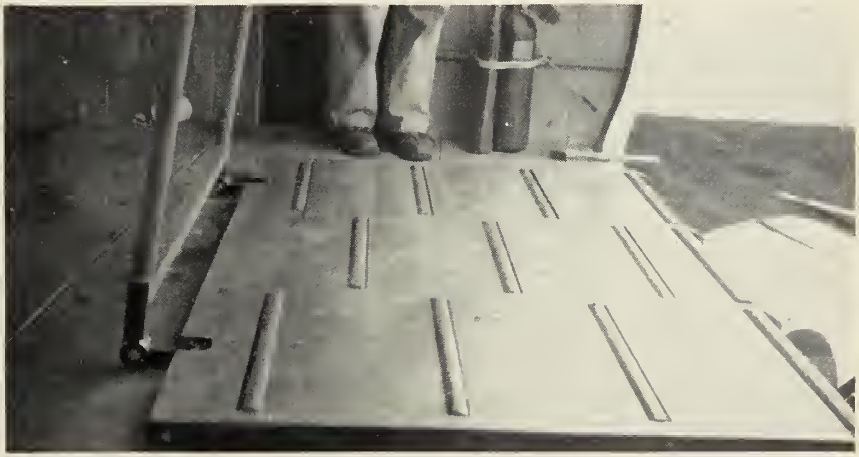


FIGURE 2.—Platform in flat position in door of airplane. Pulling the handle at left to the floor raises platform to unloading position.

CARGO DROPPER'S SAFETY HARNESS

Fire Control Equipment Development Project

Region 1, U. S. Forest Service

The development of a safety harness for use by cargo droppers has been discussed many times. Fire control personnel have been in agreement that it was badly needed but objections to its use were as follows:

1. It hampered or restricted movement of the cargo dropper in discharging bundles of air cargo unless the safety line was long enough to allow free movement inside the airplane.
2. With a restraining line long enough to allow free movement, there was the possibility of cargo droppers falling part way or entirely out of the airplane door.
3. If a parachute was not worn, there was always the possibility that, in an emergency during low-level flight, it could not be attached in time to do any good.
4. If a parachute was worn with the dropper's safety belt, there was a possibility of the parachute being opened accidentally while handling cargo, and the canopy opening outside the airplane. In this event, droppers did not want to be tied to the airplane.

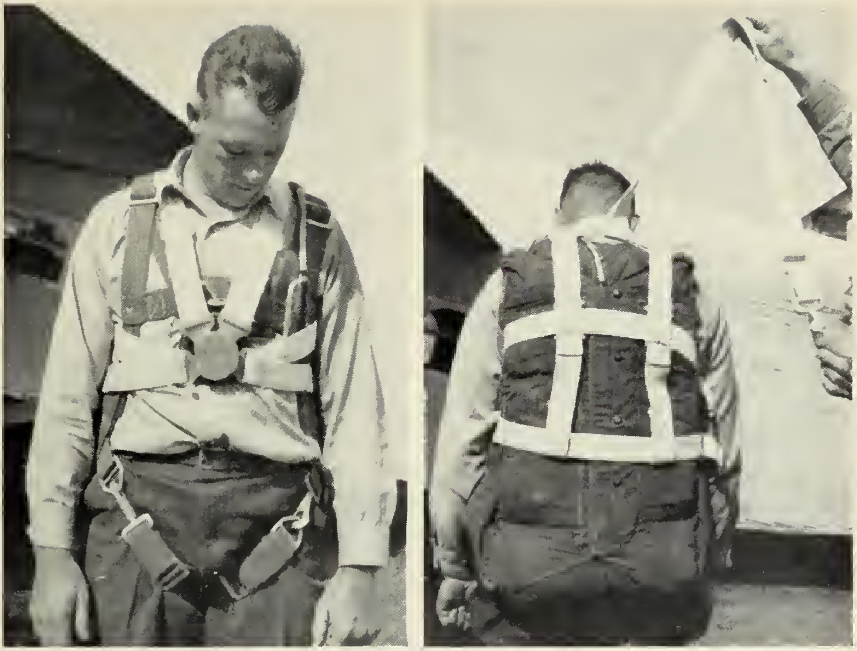
It had been proposed that a bar or strap be hung across the door of the airplane for the dropper to grab in an emergency. This substitute hampered the discharging of cargo and was never considered a satisfactory arrangement.

Discussions brought out several suggestions and possibilities which have been combined in the cargo dropper's safety harness described here.

The safety harness has been designed to use with airplanes equipped with overhead cable running lengthwise of the airplane. This arrangement is satisfactory for use by smoke jumpers or in freight delivery, and requires only that parachute static lines be of the proper length. The safety line is adjusted to allow the dropper free movement in working the cargo at the door, but in the event he should fall, the pull on the safety line swings him back towards the center of the plane to a position directly under the overhead cable. Length is such that the dropper cannot fall out of the door. Movement in the plane is accomplished by sliding the cable snap along the cable as necessary.

The harness is designed to be quickly removable in an emergency. The quick-release fastener releases shoulder and waist straps immediately when struck with the hand. There are no loops in the harness to slide out of. Until the harness is released, the parachute cannot come out of its container even though the rip cord should be accidentally pulled.

Tests of the dropper's safety harness have been satisfactory and the harness is approved by experienced men who tried it.



Cargo dropper's safety harness: Front view showing quick-release box; back view showing arrangement of harness to prevent parachute from being opened accidentally.

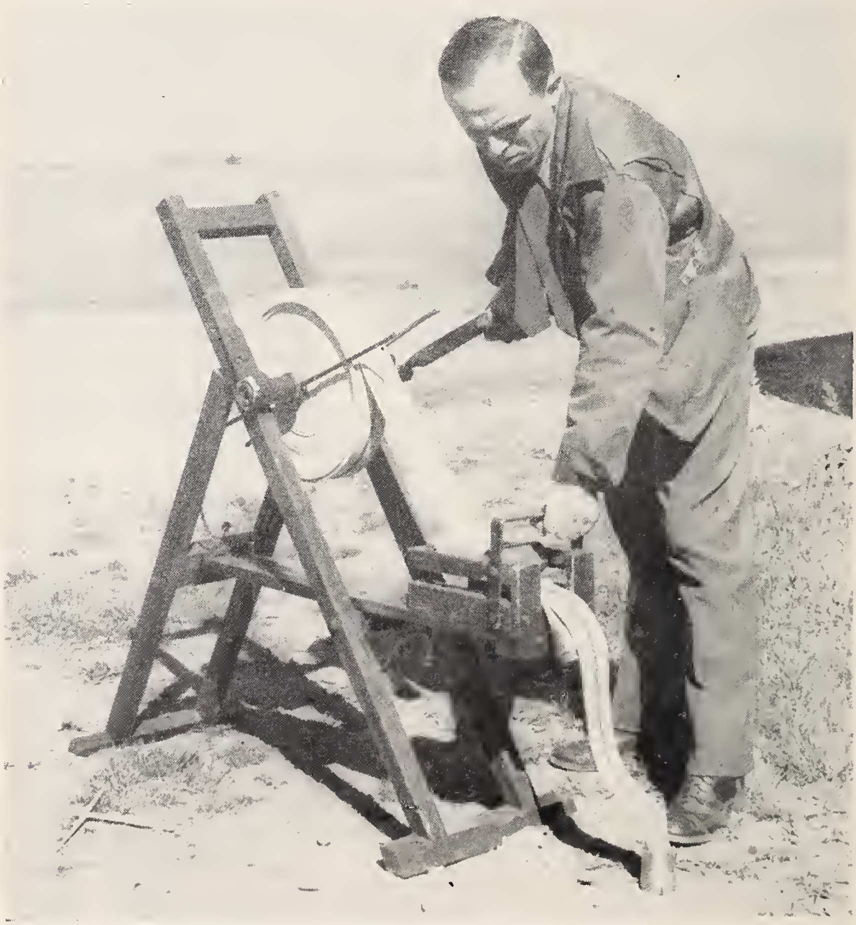
Drawings and cable installation instructions are available to those who care to make tests of the harness from the Regional Forester, Federal Building, Missoula, Mont.

[A recent report of a contract cargo dropper's life being saved by parachuting from a crashing plane only 150 to 200 feet above the ground indicates that wearing of parachutes by cargo dropping personnel has more merit than generally believed.—Ed.]

PORTABLE LINEN HOSE WINDER

AUSTIN H. WILKINS
Deputy Forest Commissioner, Maine Forest Service

The Maine Forest Service uses large quantities of 1½-inch linen hose in 100-foot lengths with slotted lug aluminum alloy I. P. T. couplings. In handling this kind of hose, fire wardens have long been interested in some portable type of hose winder. Many have devised home-made models but none which could be declared as suitable for standard equipment.



Double-rolled 100-foot length of linen hose; female end overlaps and protects male coupling threads.

In the winter of 1948 the writer attended a forest fire protection meeting of the Canadian Society of Forest Engineers at Fredericton, New Brunswick. During the meeting a portable hose winder for linen hose was displayed. Through the courtesy of the New Brunswick Forest Service a blueprint of this model was made available to the Maine Forest Service. With some remodeling of the New Brunswick sketch, Maine has made a number of these hose winders, which are now considered standard equipment for each forest fire warden's headquarters.

These hose winders are relatively simple to construct and cost of materials should not exceed 10 dollars. The main office has been securing the hardware and sending it to the warden where the rest of the construction work is completed. There are no patent rights on this winder and anyone interested can easily make his own.

In Maine the wardens are instructed to roll linen hose double with the female end longer so as to overlap the male coupling and form a guard for the threads.

Some wardens have been using this winder satisfactorily for quickly picking up wet and dirty hose off the fire lines to be loaded on to trucks and taken to the storehouse for cleaning and drying. When rolling up clean and dry hose at the storehouse, each roll is tightly wound and ready for service or storage.

This hose winder is not designed for 1½-inch single or double jacket rubber-lined hose. However, it can be used by making the side pieces of the frame above the sockets a little longer.

PUBLISHED MATERIAL OF INTEREST TO FIRE CONTROL MEN

Smoke Jumpers in Action, by J. Morgan Smith. In Disaster, April 1950, published by American Red Cross.

On Fire Prevention, by Clint Davis. In Disaster, April 1950, published by American Red Cross.

Aerial Means of Fire Suppression, by A. Koroleff, Director of Woodlands Research, Pulp and Paper Research Institute of Canada, 3420 University Street, Montreal 2, Canada. Woodlands Research Index 82 (F-3), April 1950.

Forest Fire Control, by P. A. Thompson. Journal of Forestry, April 1950.

Use of Aircraft by the U. S. Forest Service. A mimeographed paper by U. S. Forest Service, Washington, D. C., revised February 1950.

Control Wildfires—Protect Growing Trees, in Does Farm Timber Growing Pay in the South, by Extension Service and Forest Service, U. S. Dept. Agr. Leaflet 277. 1950.

Those Japanese Balloons, by Brig. Gen. W. H. Wilbur, U. S. Army, retired. Readers Digest, August 1950.

Wet Water for Forest Fire Suppression, by Wallace L. Fons. Forest Research Note 71, June 27, 1950. California Forest and Range Expt. Sta., 347 Forestry Building, Univ. Calif., Berkeley 1, Calif.

Prescribed Burning in the Slash Pine Type, in Management of Natural Slash Pine Stands in the Flatwoods of South Georgia and North Florida, by Robert D. McCulley, forester, Southeastern Forest Expt. Sta., Forest Service, Asheville, N. C. U. S. Dept. Agr. Cir. 845. 1950.

Fire Fighter—and More, by Charles A. Wentzel, senior ranger, Department of Forest and Waters, Pennsylvania. Published in the Philadelphia Inquirer Magazine, July 23, 1950.

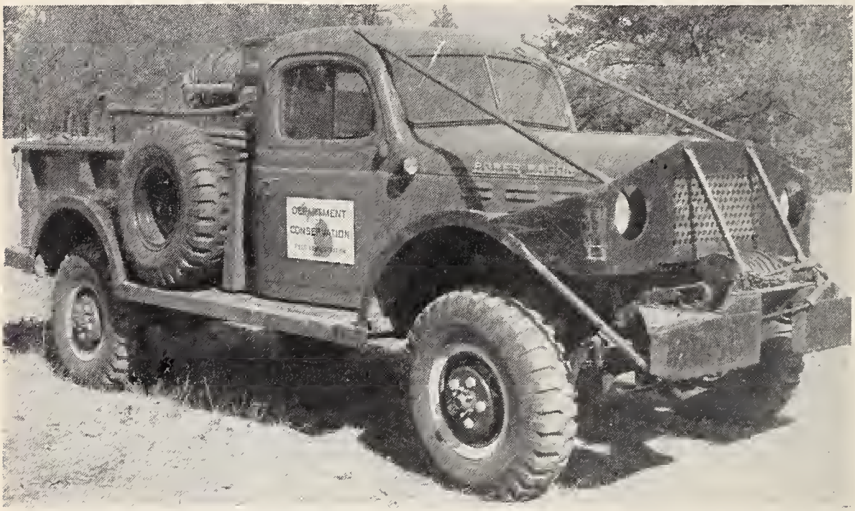
Smoke Jumpers Fight Forest Fires, in Montana, Shining Mountain Treasureland, by Leo A. Borah, National Geographic Magazine, June 1950.

MICHIGAN POWER WAGON FIRE UNIT

Gilbert I. Stewart

Supervisor, Michigan Forest Fire Experiment Station

The power wagon as used by the Michigan Department of Conservation for forest fire control is a four-wheel-drive truck that equals wheeled tractors in its ability to traverse difficult terrain. The commercial truck requires considerable refinement to adapt it to fire control purposes inasmuch as it is a standard cargo carrier.



Michigan power wagon fire unit.

The basic design was completed at the Michigan Forest Fire Experiment Station. Field experience over the past 3 years has added to the final machine and as the unit is now issued, it is the result of work and suggestion by the entire fire organization. The truck lends itself very well to use as a medium tanker for fire fighting. To fulfill this assignment, the following installations have been added to the commercial truck:

1. Drive shaft leading from the transmission and driven by the commercial attachments for the rear power take-off. Cross members were added to support bearings and the drive shaft, which is actually a jackshaft lying within the chassis frame.
2. Complete armor around the entire body. This includes a radiator grill and protection for the headlights, heavy angle members attached to the fenders and running boards, and a rear bumper and trailer hitch.

3. Slip-on tank unit mounted on a skidlike base. It is removable and may be repositioned exactly by indexing points. The tank unit also includes a high-pressure pumping unit mounted on a steel deck behind the tank. The pump is driven by a multiple V-belt system from the special drive shaft mentioned. A hole in the truck deck permits passage of the belts from the shaft to the pump sheave, and a guard covers the belt system. Capacity is 15 gallons per minute at 600 pounds pressure. Also included in this pumping system is a tank filler operating on the ejector principle. Its purpose is rapid refilling of the tank at supply points.

4. Live reel for hose storage and pumping service.

5. Full radio equipment. This consists of an FM unit operating on a frequency of 46580. The radio instruments are in a steel case mounted on top of the tank. Cables run from the instruments to controls on the dashboard near the driver. They are contained in waterproof and steel casings.

6. Complete tool equipment for pumping service, maintenance, and field upkeep. This includes all pump accessories, nozzle gun, etc. All of these items are contained in a sturdy tool box with recesses for each part. Full operating instructions are mounted in a watertight frame in the lid of the box. For purposes of compactness and utility of space, the tool kit is carried on top of the radio case and below the level of the cab.

This outfit is assigned as initial attack equipment. The tank capacity of 300 gallons permits working time of 1 to 1¾ hours depending on fuel types and skill of operator. Accessory equipment consists of two hand-operated plunger pumps, three shovels, and one ax. Two seats may be mounted at the rear of the body for extra men. The normal crew need not exceed four men.

This model of power wagon and the additional equipment has been under development and production by the Michigan Department of Conservation since 1946. Twenty of these are now in service. Full print specifications have been completed as well as tooling for production. Patterns for all necessary castings are completed. Total cost averages about $3,300, not including radio equipment.

Experimental work to extend its usefulness in fire control is being continued at the Forest Fire Experiment Station. Included in the experiments is the attachment of hydraulically operated plows at the rear of the truck, to be used when possible in line building.

It should be borne in mind that the power wagon does not compete with crawler tractors and plowing units. Its development was intended to provide a relatively fast tanker that would not be roadbound. It actually supplements the crawler tractor and plow. These two units cooperating as a team are capable of effective action, especially at heads of fires where line must be built or where critical sectors must be held while line is being built and at critical points not hitherto possible of attack.

Additional information on this unit may be obtained from State Department of Conservation, Lansing, Mich., or Michigan Forest Fire Experiment Station, Roscommon, Mich.

SOUTH CAROLINA'S TYPE C–150 LIGHT SUPPRESSION PLOW

J. A. McLees

Fire Control Engineer, South Carolina State Commission of Forestry

This plow was designed and developed by the Engineering Section, Branch of Forest Fire Control, South Carolina State Commission of Forestry to fill the need for a light suppression plow that could cope with conditions encountered in the heavy and wet soil types of the coastal plains region. Development was started in January 1950, and the plow was ready for "fire test" during the spring blow-up. Specifications are as follows:

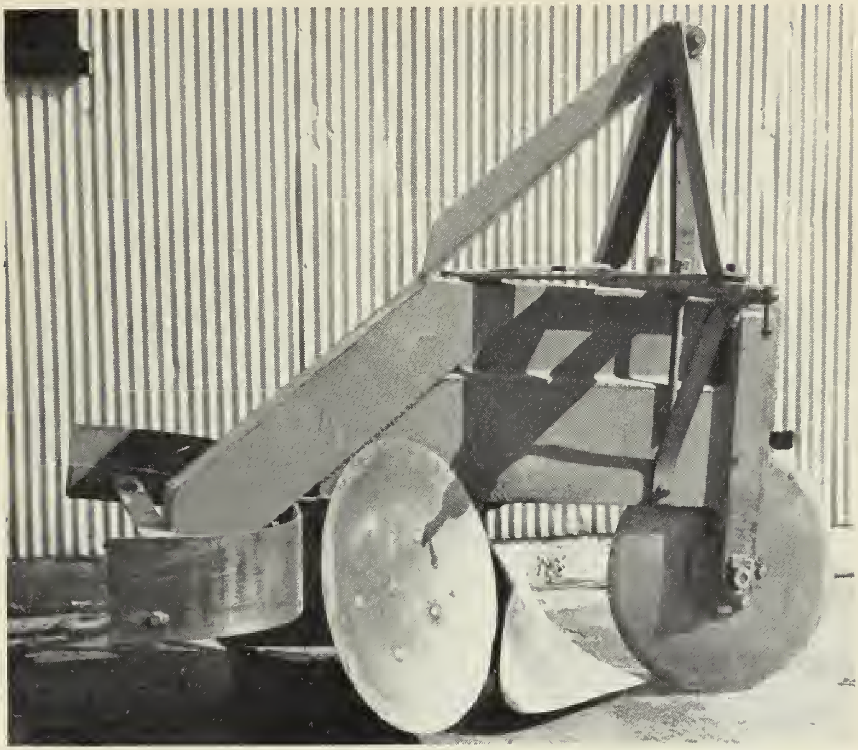
Weight	515 pounds.
Coulter:	
Construction	Cast steel (South Carolina State Commission of Forestry foundry pattern).
Outside diameter	18 inches.
Shape	Cast taper, machine beveled.
Hub	Steel plate, bronze bushing.
Lubrication	Zerk fitting.
Middlebuster point	Cast steel (South Carolina State Commission of Forestry pattern).
Disks	18-inch diameter, farm type.
Main beam	Design; high torque resistant box beam.
Draw bars	Same as Dearborn Cross draw bar.

The middlebuster plow point is not of commercial manufacture, but is of cast steel from a pattern developed by the commission.

Pilot models of this plow carry coulters of machined steel plate. Production models are fitted with a heavy steel coulter, machine beveled, and cast from the commission's aluminum pattern.

The 18-inch disks are carried on heavy duty, dust-sealed hubs, cast from the commission's foundry pattern. The hubs are fitted with Timken bearings. Disks are of commercial manufacture.

The firebreak cut by the unit has an average depth of 4 inches with a cut width of 30 inches. The cut section together with the variable throw provides an effective firebreak of 42 to 60 inches, depending upon the soil condition. The plow constructs an exceptionally clean line and its sturdy construction is an advantage over many other types of light suppression plows tested under South Carolina conditions. It is adequately drawn by Ford or Ford-Ferguson type tractor equipped with bombardier half track system or the H. G. crawler tractor in the 20 horsepower range.



Light suppression plow with specially designed middlebuster plow point and coulter.

Portable Electric Megaphone.—Late in the fall of 1949 a portable electric megaphone was loaned to the Superior National Forest by a commercial company, for testing the feasibility of broadcasting messages from airplanes to ground crews engaged in fire suppression. The short time remaining in the fire season left little opportunity to make exhaustive tests and come to any very definite recommendations. However, some tests were made from each of the three Forest Service planes.

Reception, volume, and clarity was very good from the two-place Piper Cub at elevations near 500 feet. At 1,000 feet reception was fair, while at 1,800 feet it was intermittent, i. e., fair if plane was up wind from the listener, and not audible if the plane was down wind.

A test was afforded from the four-place Stinson during the search for a lost hunter. With the plane flying at an elevation of 500 to 800 feet over an area of about four square miles, the searching party was able to clearly hear the announcement that the lost man had been found. On another occasion, the megaphone operated ground-to-ground points during a stormy night trying to call a lost hunter out of the woods. It was later learned that the hunter heard the voice of the searcher but, it being night, was afraid to leave his fire.

When the megaphone was operated from the Noorduyn-Horseman nine-place plane, reception was poor. This was probably due to the high noise factor from the plane and the elevations required for flying the large-sized craft.

From the few tests made, the Superior Forest believes the megaphone would be very practical in talking to fire crews from small planes such as the Cub and Stinson. It would also be practical in large fire camps for amplifying instructions and announcements.—W. J. EMERSON, *forester, Fire Control, Superior National Forest.*

PRELIMINARY REPORT ON THE USE OF A TRACTOR-PLOW IN THE SOUTHERN APPALACHIANS

R. D. Williams

District Ranger, Chattahoochee National Forest

An H. G. crawler tractor with a middlebuster plow has been used in fire suppression on the Armuchee Ranger District since the spring of 1949 with promising results.

The Armuchee is the westernmost district of the Chattahoochee National Forest situated in northwest Georgia. The area is characterized by a series of long linear ridges rising up to 800 feet above the floors of the intervening, wide agricultural valleys. Most of the 146,525 acres protected lie in the ridges where soils are stony and large rock outcrops are frequent. Topography is rough and slopes are steep. About one-fourth of the timbered area is a hardwood type, and the other three-fourths yellow pine-hardwood. Underbrush is heavy and fires in the predominant leaf-needle litter burn with a high rate of spread and medium resistance to control. Slash areas resulting from heavy logging of private lands, and sedge grass and advanced reproduction on numerous abandoned fields interspersed throughout the area, form the most explosive fuels.

During the 5-year period 1944–48 an average of 31 fires burned 784 acres annually. Prior to 1949 suppression was handled entirely with hand tools by the district ranger, 2 seasonal Fire Control Aids, and 7 voluntary fire wardens with trained "pickup" crews. The original force has been retained. The tractor-plow was added to strengthen the organization. Although approximately 10 percent of the protected area is too rough for tractor operation, fires occur infrequently in the rougher sections, and during 1949–50 the unit could have operated on every fire that occurred.

The tractor-plow assigned to the Armuchee District has a total weight of 5,130 pounds, total length with plow lowered of 14 feet, and maximum width of 5 feet. Treads are 10 inches wide. The 4-cylinder motor gives tractor speeds at governed motor speed of 2.02 miles per hour in low gear, 3.19 miles per hour in second, 5.25 miles per hour in high, and 2.35 miles per hour in reverse.

To the commercial tractor were added: Heavy radiator guard; brush guard rising 3 feet above the operator's seat; safety guard over the top of the treads; front bumper reinforcement of 300 pounds of railroad steel to counterbalance the weight of the plow; and a spotlight and rear-mounted headlight (or taillight with clear lens), which were essential for night work. Mounted on the tractor is a back-pack pump, drip torch, three council rakes, short-handled shovel, and Pulaski tool. A standard six-man tool box is mounted on the carrier truck.

The plow weighs 398 pounds and is raised and lowered by a hand winch. It is adjusted for depth of line by changing the pitch of the beam at the clevis. The plow has a 24- by 32-inch moldboard and 36-inch wingspread. In most soils it constructs line 6 inches deep at the center and 54 inches in width, including throwback.

The unit is transported on a 1½-ton stake truck with a 7- by 9-foot flat body and a 5-foot ramp sloped to a 21-percent grade. Portable runplanks complete the ramp to the ground. The truck can travel safely at 45 miles per hour on good roads and the unit can be unloaded and placed in operation by two men in 1 minute (fig. 1).

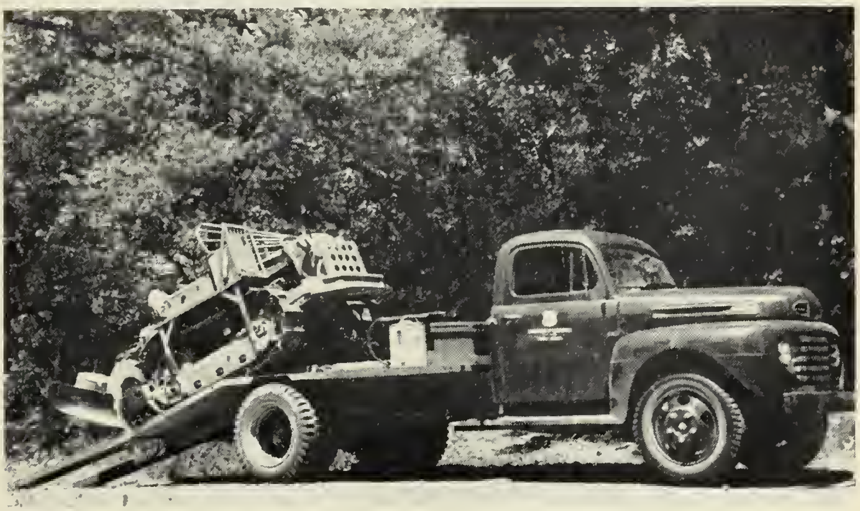


FIGURE 1.—Unloading the H. G. crawler tractor with middlebuster plow. The unit can be unloaded and placed in operation by two men in 1 minute.

The tractor operates efficiently downhill on slopes up to 70 percent, uphill on slopes up to 40 percent, and sidehill on slopes up to 45 percent (fig. 2). Where slopes are too steep for sidehill and uphill operation, the tractor is backed uphill and builds line downward. The outfit performs satisfactorily in rough, rocky terrain and good results have been obtained on night fires.

Organization plans call for immediately dispatching the tractor-plow to every fire in "plowable" area as shown on the control map. When the need is indicated, a warden crew is also dispatched to handle sections of the line too rough for the tractor, and to perform mop-up so as to release the tractor crew for another fire. On class 2 and 3 days, the tractor crew consists of the operator, backfire torchman, and follow-up man with a council rake and back-pack pump. On class 4 and 5 days, two additional men are carried to back up the line. A front scout is necessary if the country is very rough and is always necessary at night. Most fires are controlled by the parallel method as our fires seldom crown. Fusees were found too slow for line firing but drip torches have been used with good results.

From January 1, 1949, to June 30, 1950, 51 fires have occurred on the district. The tractor-plow was dispatched to 36, or 71 percent.

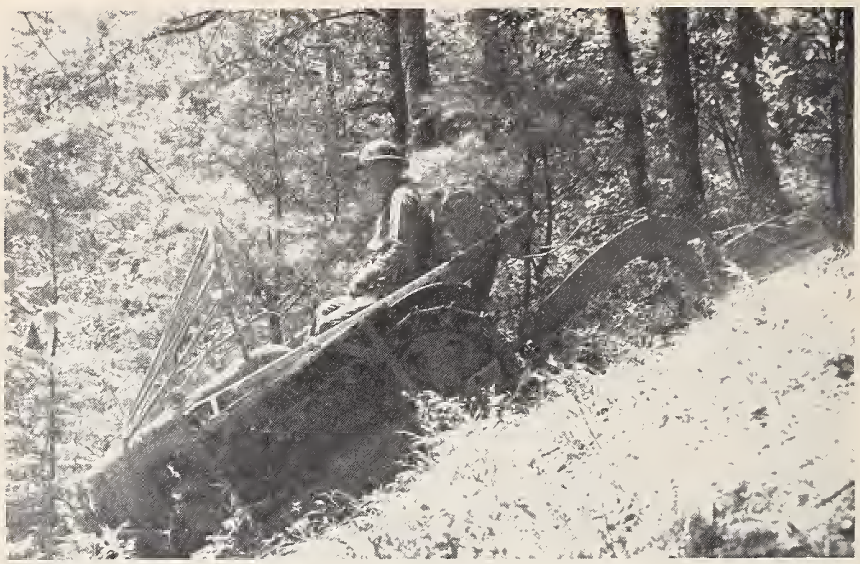


Figure 2.—Downhill operation on a 70-percent slope. The tractor performs well in steep, rocky terrain.

of these and operated on 29 fires, or 59 percent. It was not needed on arrival at 7 fires and was not dispatched to others through error in judgment or because it was known that it would not be needed. The unit built 895 chains of line at an average rate of 50.6 chains of held line per tractor-hour and a held line average of 16.9 chains per man-hour on the tractor-built sections. Table 1 shows the results obtained on the 29 fires occurring in 1949–50 and 129 fires controlled entirely by hand during the period 1944–48, inclusive. Class A fires and fires occurring on class 2 days were eliminated from the analysis as these are usually easily handled and offer no test of suppression methods.

Table 1.—*Average size of fire and average time on suppression for hand-tool and plow control on class 3 and 4 fire days*

Fire day and control method	Average size of fires			Average time on suppression		
	Area of attack	Final area	Increase	Line construction	Mop-up	Total
	Acres	*Acres*	*Percent*	*Man-hours*	*Man-hours*	*Man-hours*
Class 3:						
Hand-tool	10. 3	18. 8	83	14. 53	19. 67	34. 20
Plow	8. 8	11. 4	30	5. 74	12. 00	17. 74
Class 4:						
Hand-tool	18. 6	46. 9	152	36. 32	29. 00	65. 32
Plow	8. 6	12. 3	43	5. 98	18. 00	23. 98

Plow-controlled fires are smaller at initial attack because the unit is immediately dispatched, whereas warden crews are more slowly gathered and get-away time is longer. The final average size is considerably smaller and the advantage of plow over hand-tool control increases sharply as fire danger rises.

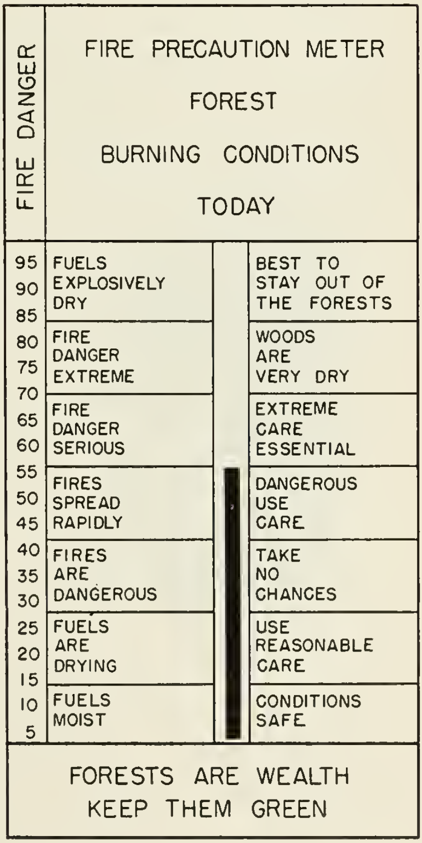
Operation and depreciation of the tractor and plow was established at $5.25 per hour. Based on wage rates now prevailing in this locality, the average plow-controlled fire was suppressed at a cost of $22 as compared to $36 for the hand-tool controlled fires. Past occurrence of 26 fires annually on class 3 and 4 days, class B and larger, indicates annual savings of $364 in suppression costs. On this basis alone the equipment is a paying investment. However, greatest saving is the reduced acreage burned and reduction in possibility of large disastrous fires. The outfit, too, has a definite prevention value. Job fires which were becoming a problem in one area practically stopped after the tractor was persistently used in place of hand labor.

Fire Precaution Meter.—The more the traveling public and local people become aware of fire danger conditions, the more we can expect caution will be used by people in forested areas during the fire season. For that purpose, a fire precaution meter was devised on the Helena Forest in 1937. Both of the local daily papers, Montana Record Herald and Helena Independent, agreed to carry the meter each day during the fire season. It attracted immediate attention and comment by local readers, and the two papers came back with a request for it in 1938. The first printing was accompanied by a short article explaining the purpose, etc. It was devised as a representation of a thermometer with a line in the center to represent the mercury tube.

Recently revised slightly to fit the present class 100 danger meter, and with some change in wording, it is now being carried in Coeur d'Alene, Idaho, and Spokane, Wash., dailies during the fire season. Similar precaution meters could well be devised for use in daily papers in other regions and parts of the United States where fire conditions and man-caused fires are a problem during varying seasons of the year.

The meter has little value other than in daily papers. It carries a very brief description of each of the seven fire danger levels in the left-hand column. Opposite are briefed measures of precaution which should be observed by people living or traveling in forested areas. A studied attempt was made to carry the message to the readers in language readily understandable to anyone able to read.

It must also be remembered, once such an arrangement is worked out with a newspaper, an obligation exists to decide on what danger rating is to be run and notify the person who is to receive the information in plenty of time to go to press.—V. L. Collins, *district ranger, Colville National Forest.*



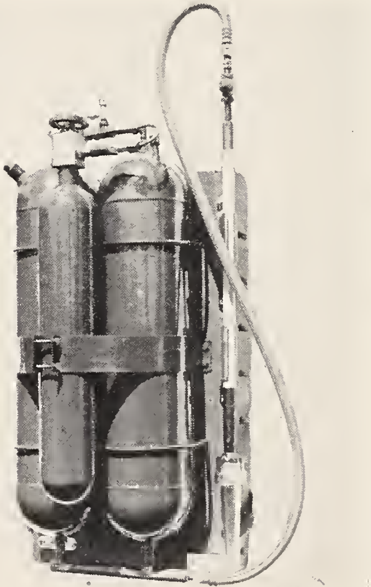
CO_2 BACK-PACK OUTFIT

A. B. Everts [1]

Fire Staffman, Snoqualmie National Forest

The subject of pressurized back-pack outfits has come in for considerable discussion by forest protection men. Usually the discussion centers around the use of a CO_2 cartridge for discharging liquid from a pressure cylinder. The disadvantage of the cartridge idea is that the pressure does not remain constant. In order to have sufficient pressure to properly expel the last of the extinguishing agent, it is necessary to overcharge the cylinder at the beginning of the operation. In the dry powder type of extinguishers this problem is provided for by using a heavy cylinder for the powder. This, obviously, increases the weight and would be undesirable in a back-pack outfit.

Test data were obtained on a constant pressure back-pack outfit, constructed mostly from surplus materials. To check pressure data the test outfit was provided with a pressure gage. This gage would be unnecessary for field use. The price a manufacturer would have to get for such a unit, using new materials, would probably be out of reach for most protection agencies. Nevertheless, performance data are interesting.



The CO_2 bottle in the center will expel the two presure tanks better than seven times, maintaining a constant pressure of 100 pounds. Plastic foam nozzle is shown.

Two surplus, stainless steel, shatterproof oxygen tanks with a combined capacity of 4¾ gallons were fastened to a plywood packboard. These tanks were tested to 600 pounds and provided with a safety release set at 200 pounds.

A 10-pound CO_2 bottle (also surplus) containing 3¾ pounds of CO_2 is mounted between the two tanks.

A regulator valve (surplus) set at 100 pounds is screwed into the outlet of the CO_2 bottle. This valve has a soft blow-out disk as is common with such regulators. Thus, there are two safety devices. This valve allows the CO_2 to feed into the pressure tanks through a copper tube, keeping the pressure constant at 100 pounds.

The two tanks are joined at the top and bottom by tubes so that only one filler cap is needed. This arrangement also permits equal pressure distribution.

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[1] Recently transferred to the Division of Fire Control, Northwest Region, United States Forest Service, to handle fire control equipment.

The nozzle is a 2-foot tube which can be provided with straight stream and fog or foam tips of any desired design or capacity. A press button, spring tension valve, operated by the palm, controls the discharge. There is no doubt that this arrangement allows more efficient water application than the hand-operated pump common on back-pack outfits.

The weight of the unit, fully charged with liquid and CO_2, is 65 pounds, or 10 pounds heavier than the conventional units.

With the temperature at 48° F. the 3¾ pounds of CO_2 expelled the two tanks eight times. On the last charge the pressure dropped to 20 pounds.

Using a small plastic foam nozzle and one quart of high expansion mechanical (liquid) foam and the rest water, 35 gallons of foam was measured. Thus, the potential foam capacity of the CO_2 is 280 gallons. The unit operated for 2 minutes, producing foam at the rate of 17.5 gallons per minute.

The unit operated 3¾ minutes with a straight stream tip; 1¾ minutes with fog. These figures mean little, however, as the size of the orifices in the tips determine the length of operation.

The disadvantage of a pressure unit of this kind, besides the cost, is that the CO_2 bottles have to be recharged. In most locations this entails shipping the bottles to a refilling plant. Open top converters, which could be recharged on the ground with dry ice, would be an improvement. Using wet water and the proper fog tips, the unit should be an effective outfit for extinguishing fires in overstuffed furniture and mattresses, a common type of fire for city fire departments. The foam unit should be effective on restaurant range fires, involving burning grease. On the forest fire line, however, it is a little too complicated and too subject to injury. For motor patrolmen, it might have a value.

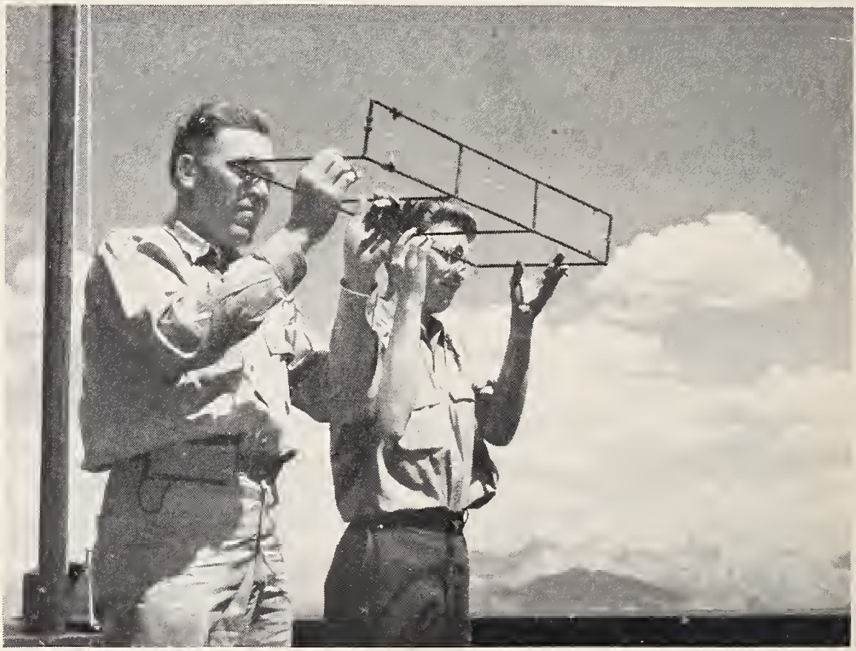
For home use applying 2–4D, DDT, or whitewash with a fog tip, it definitely has possibilities—approximately 32 gallons of liquid easily and effectively applied with 3¾ pounds of CO_2. If the unit had an open top converter, it would cost about 12 cents to recharge the converter with dry ice.

[Additional information may be obtained from the author, in care of Regional Forester, Post Office Building, Portland 8, Oreg.]

A SIMPLE LOOKOUT TRAINING AID

Glenn E. Brado
District Forest Ranger, Sawtooth National Forest

Each time a new man is placed on a lookout he has to be trained in the various phases of the lookout job. One of his first duties is to "learn the country." This may be done in a number of ways but we have found the training gadget shown in the photograph to be very useful.



Training aid being used; dimensions are 36 by 12 by 4 inches.

The framework of the training aid is ¼-inch iron rod, welded together. The frame may be made any convenient size but should be long enough to enable the trainer and trainee to stand side by side. The cross hairs on one end of the frame are attached to movable sleeves which are locked in place with one-quarter-inch nuts. This provides for adjustment in making the lines of sight parallel. The eye pieces are one-quarter-inch flat washers welded in place; and the cross hairs are made of length of fish line.

To adjust the training aid, simply place the frame on some convenient support with the rigid cross hair centered on some prominent object a mile or so away. Then, without moving the frame, adjust the movable cross hairs until they are centered on the same object. If the eye pieces are 30 inches apart and the lines of sight are parallel, the error will be negligible for lookout training purposes.

The training aid can be used by the training officer in pointing out features of terrain such as creek bottoms, ridges, and prominent landmarks, or by the ranger or other inspecting officer in checking on a lookout's knowledge of the terrain.

In training, the instructor and trainee stand side by side. The instructor should control the movement of the frame and hold his cross hair on the particular topographical feature he is describing. The trainee lightly supports his end of the frame and follows the instructor's movements. With the frame in proper adjustment it is readily apparent that both men look at the same object. By slowly moving the frame, the instructor can trace out creek bottoms, ridges, etc., and the two men can carry on a conversation at the same time.

For checking a lookout's knowledge of the country, the procedure is reversed. As an example, the ranger may ask the lookout to trace out the ridge between Lake Creek and Eagle Creek. The lookout then controls the movement of the frame and the ranger follows his movements.

This training aid is a good supplement to the map and fire finder, and has the following advantages: (1) It can be made in any shop in a very short time, using materials on hand; (2) it is especially useful in pointing out difficult terrain; and (3) it is a time saver.

Air Force Fights Fire on Tonto Forest.—The advantage of airborne attack forces was brought home to the Tonto National Forest on the Lewis Creek fire in June. The fire was discovered under the Tonto Rim about 2 p. m. on a Saturday afternoon, the opening date of the fishing season, a time when it is very difficult to secure local help. Shortly after 3 p. m. it was determined that adequate local help was not available, and a call was made to Williams Field, approximately 130 miles away. Men were assembled, flown to Payson Airport, and hauled 20 miles by truck, all within a period of less than 3 hours.

Twenty-five arrived in the first crew, all in one plane. They were young, husky individuals, willing to work; in fact, anxious to do so. Two of them were assigned to kitchen detail, and were most unhappy because they were prevented from fighting fire. An experienced crew boss was assigned to each five men. The men were held for approximately 24 hours, on the fire line over half the time. Then another crew of 25 was flown in and the first group returned to Williams Field. These men arrived on the fire in less than 3 hours, and after the first call could have been gotten there in less than 2 hours. It would have required at least 12 hours to secure men by truck from any other outside source.

This splendid cooperation resulted from a "memorandum of understanding" which was developed several years ago between the 3525 Pilot Training Wing at Williams Air Force Base and the Tonto National Forest for emergency use. The agreement provides for furnishing from 25 to 200 men by the Air Force, including transportation, suitable clothing, rations, and kitchen and mess equipment, as well as drinking water facilities and medical attention, and goes into some detail as to the procedure of assembling the men. They are recruited on a voluntary basis. We were told by the officers in charge that not the least difficulty was experienced in securing men. They said at least 200 would have volunteered, and they were anxious to come. This was borne out by the attitude of the men on the job, who really seemed to enjoy working on the fire, in spite of the fact that it was difficult and arduous labor. The businesslike and courteous attitude of the men generally was a source of much faborable comment by those who had an opportunity to work with and observe them.

The prompt and efficient action of the Williams Air Force Base undoubtedly averted a serious fire which would have caused great damage to an important recreation area and other national forest resources—PERL CHARLES, *assistant supervisor, Tonto National Forest.*

USE OF LIGHT PUMPERS AND AIRPLANES ON THE SUPERIOR NATIONAL FOREST

William J. Emerson

Superintendent, Ely Service Center, Superior National Forest

For many years fire control in the Superior lake country of Minnesota was exteremely slow and difficult and meant many hours of canoe travel and cross-country packing before the fire was reached. The seaplane, however, together with improved lightweight pumper units and other portable equipment, has revolutionized fire control work in this very extensive area of high recreational values. Water bodies are so numerous, and roads so few, that in many sections all other control methods are considered very difficult or impossible. In fact the seaplane-portable pumper combination has been developed to a point of such efficiency that it is used in initial attack on all fires not readily accessible by motor vehicle, and the portable pumper is a primary tool for mop-up. Even on many fires along roads, it is frequently possible to get quicker action by dispatching a plane pumper outfit from the seaplane base at Ely to a lake near the fire.

Because of existing roadless-area laws and the fact that roads are extremely difficult and costly to build, there will always be many extensive sections where motor vehicles may not be used. Fortunately, this Superior country is blessed with numerous lakes on which seaplanes may land (fig. 1).

The lake shores and islands of the Superior lake country are its areas of greatest fire risk, and the high percentage of fire occurrence in such spots makes the seaplane-pumper combination extremely effective. Every year many shore fires start in the lake country (usually from camp fires), and it is a common experience to suppress such fires with only 100 or 200 feet of hose, quickly landed from a Forest Service plane.

The basic equipment maintained by the Forest Service at the Ely Service Center and Ely Seaplane Base consists of 3 seaplanes and 20 portable pumpers complete with accessories and linen hose. The heavy fire suppression and other transport work is done by the 550-horsepower Noorduyn-Norseman, which can carry as many as five pumper-hose units complete with gasoline and accessories (fig. 2). Or it can transport two or three complete units with pumper operator and hoseman for each unit. Eight fire fighters with personal effects can be carried in the Norseman besides the pilot. The two lighter planes, a 165-horsepower Stinson station wagon and 65-horsepower Piper Cub, are used primarily for detection patrol over the roadless areas and for scouting and mapping work on going fires. All three planes are float-equipped.

Recently the Superior has been experimenting with new smaller and lighter pumpers that can be carried to small fires in the two lighter patrol planes. Of particular interest is the new Pacific Marine light-

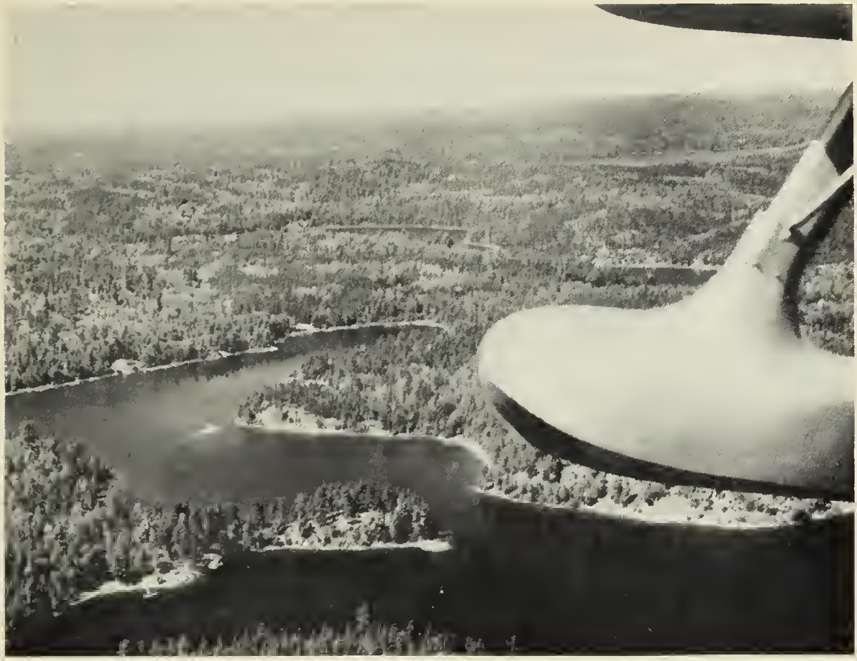


FIGURE 1.—Superior roadless area.

weight "A" pumper which weighs only 36 pounds and is small enough to be carried in the four-place Stinson patrol plane with a two-man pumper crew besides the pilot (fig. 3). A kit, made up to accompany this new pumper, consists of lightweight accessories, 1-inch linen hose in knapsack, small suction hose, and enough mixed gasoline to supply the pumper for the ordinary small shore fire. Small ax, pulaski, and lady shovel complete the kit. The entire pumper unit with hose and accessories weighs only 100 pounds. Use of the smaller plane enables the small initial attack pumper crew to land on many small lakes where the large Norseman plane could not safely land or take off.

The new, lightweight pumper has been in trial use only part of one season and little is yet known about its performance on the Superior, particularly in the many places where the vertical lift from the lake shore to the head of the fire is rather great. On one of the few fires where it was tried during the fall of 1949, the rough, rocky nature of the shore line prevented the seaplane from getting in close. The fire was close to the shore, so the pumper was set up on the float of the plane and the two-man hose crew swam to shore with the light hose. With the seaplane pilot operating the pumper, the crew knocked the fire down with direct water attack before it could get a good start.

Most of the fires which start in this area originate from campfires or lightning and usually require only one pumper unit to be suppressed. However, anywhere from 1 to 10 or even 20 pumper units may be dispatched, depending on information furnished the dispatcher by the patrol plane observer discovering the fire and by subsequent aerial scouting. A short-wave FM radio network, with radios in each plane and tower, portable radios on the ground, and a central control set in

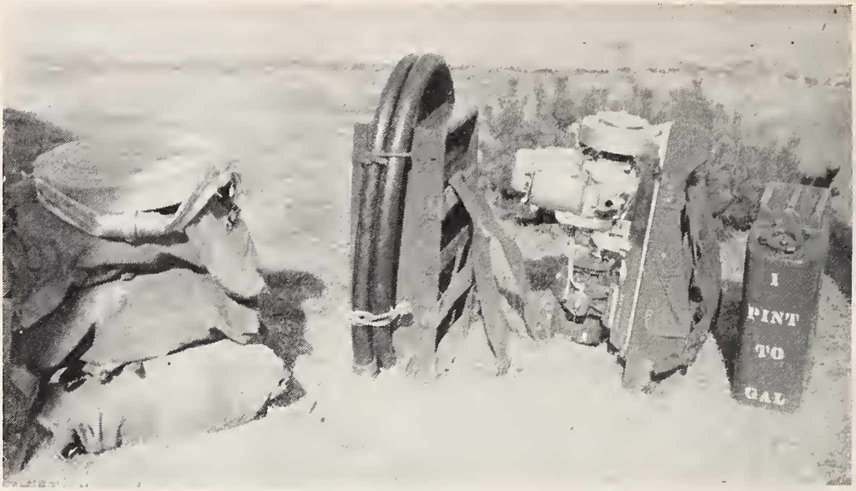


FIGURE 2.—A typical airplane pumper unit on the Superior: Pumper on pack frame, accessory box with intake hose, mixed gasoline, and 1,500 feet of 1½-inch linen hose. This unit is usually transported in the Norseman seaplane with a 4- or 5-man crew for fighting fires in the lake country.

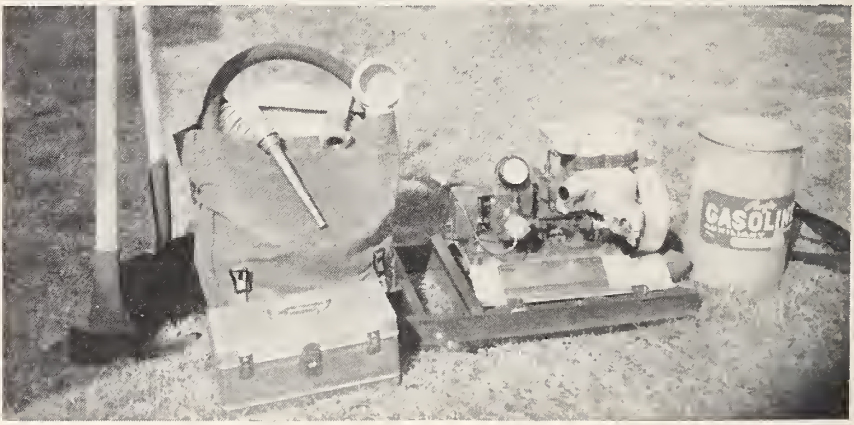


FIGURE 3.—Components of the 100-pound fire kit. Pumper is the new Pacific Marine "A" weighing 36 pounds, mounted on pack frame. This can be operated on shore and island fires in the Superior wilderness country by two men. These two men, the pilot, and the 100-pound kit make up the pay load for the four-place Stinson seaplane.

dispatcher's headquarters, gives excellent communication in this vast forest-lake area. Thus pumper units may be moved from one fire to another without returning to headquarters for instructions.

During peak periods of hazard and risk, small pumper units with two- or three-man crews are sent along on detection patrol flights, so that direct attack may be made on any fire discovered. With this system, fires may be attacked by the small pumper crew only minutes after being discovered by the patrol plane, thereby saving much time and the resultant larger force required by a larger fire.

The new pumpers are also very practicable where the fire suppression equipment must be packed long distances across country. Their compactness and light weight are a vast improvement in this area over the older, heavier portable pumpers, and the small hose and accessories add to the improvement. Two men can pack a complete "A" pumper-hose outfit plus a couple of hand tools apiece for some distance cross country without experiencing severe exhaustion upon arrival at the fire. Here again, Forest Service airplanes frequently make the difference between success and failure on the control job. As soon as a fire is discovered, the dispatcher is able to determine the amount of hose needed by having the plane locate the nearest water chance and estimate its distance from the fire. The direction and distance from the fire and other description of this water chance is provided the pumper foreman so he takes enough hose, but not too much, which would tax unnecessarily the carrying power and speed of the crew going to the fire across country.

On many of these back-country fires, water chances may be available that do not show up on the map. Very small pot holes, wet swamps, intermittent streams, etc., provide enough water hose for fires in many places. During spring and fall, and during wet summers, there have been instances where the only water close to the fire was that lying in a low spot in an old winter logging road. The trained aerial observer is often able to spot such water chances, thereby giving the disptacher and pumper foreman invaluable information shortly after the fire is discovered.

The air observer, by means of FM handy-talkies, is able to direct the pumper crew to the fire or water chance, or both. One member of the crew carries the handy-talkie, while his partner carries a bright orange flag. The air observer cruises overhead, following the course of the crew toward the fire by sighting the orange flag waved periodically by the crewman. Every few minutes, the handy-talkie operator pauses and calls the observer, who gives him new estimated bearing and distance to the fire from his present position. Thus, the fire crew is "talked in" to the fire, sometimes saving them miles of needless wandering en route, and much valuable time.

Many lightning fires on the Superior start in snags or large trees in areas where dirt is practically absent, the soil types being muskeg swamp and solid rock. The small lightweight portable pumper is the best tool for these fires, but the problem lies in finding the burning snag or tree without carrying the portable pumper many needless miles during the search. Here the plane-to-ground radio directions are invaluable, and several times the crew has been "talked in" over long distances to a single burning tree or snag by means of the handy-talkie and bright flag. Similarly the crew may be directed to the best and nearest water chance discernible from the plane. Incidentally, this system is beginning to be used effectively in locating spot fires on large fires.

In addition to the Pacific Marine "A" and "Y" portable pumpers in use on the Superior, another quite satisfactory portable pumper has been made available by remodeling work in the pumper repair shop at the Ely Service Center. A Pacific Marine "N" pumper has been converted to one called the "AN" locally by cutting off two of the four cylinders and shortening the shaft and pumper length several inches. Satisfactory performance for most chances is obtained and the improvement in weight and portability is an advantage, especially on back-country fires and fires handled by boat and canoe transportation.

The Superior National Forest is currently experimenting with various lightweight accessories and supplemental equipment to enable portable pumper fire crews to get to fires quicker and easier, and to move their equipment faster and with less difficulty from one point to another on a fire.

One of the recent developments being tested is the new Harodite canvas relay tank or "dike" (fig 4). This is a heavy, treated canvas tank, pyramid-shaped with intake and output vents in the top. The Superior now has, for trial use, a 150-gallon tank and a 300-gallon tank. In a tank of this shape, the water supports the canvas structure without any additional legs or other supports. These canvas relay tanks are very portable, folding to a flat bundle about 1½ feet square which may be easily carried in a small packsack. Thus the several pumper relay tanks needed in a very long or steep hose lay could be readily carried in packsacks by a couple of men.

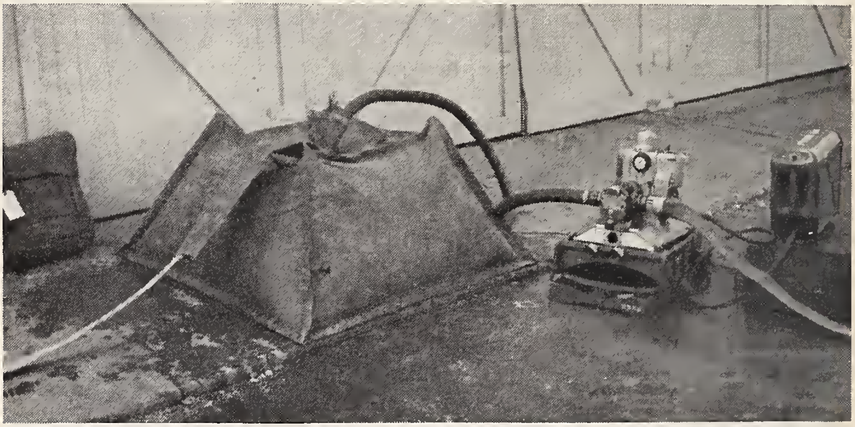


FIGURE 4.—Typical relay set-up: Canvas relay tank, 150-gallon capacity, pumper, and special gas can. Knapsack at extreme left contains a 300-gallon canvas relay tank folded up for transporting to a fire.

Fires in the Superior border-lake country usually occur in midsummer, when the very deep duff dries out and provides a ready avenue of travel for the fire down deep among the rocks. Here resistance to control frequently reaches extreme proportions. A large fire in this area is a very costly, back-breaking operation, extending over a long period of control and mop-up. The portable pumper-seaplane combination seems to be the answer to the question of how to keep most fires small to avoid disastrous and expensive project fires in this extensive area which is otherwise so inaccessible.

USE YOUR WEATHER RECORDS TO INTERPRET FIRE-WEATHER FORECASTS

Owen P. Cramer

Meteorologist, Pacific Northwest Forest and Range Experiment Station

"The weather man missed it!" You've probably made that kind of statement about a fire-weather forecast yourself.

What actually happened though, might well be described like this: "The area forecast was not interpreted in terms of the topographic and cover effects at the particular point for which it was used." You can understand why such a description is more accurate by thinking about the nature of fire-weather forecasts and how topography and cover in your district might affect the weather.

The routine fire-weather forecast is an area forecast. Among other things, it describes the general conditions of air flow and the temperature, humidity, and other properties of the air mass the forecaster expects to be present over a large area, say 3,000 to 5,000 square miles. A typical western forecast area has more or less mountainous terrain with cover varying from rocky barrens to old-growth forests. The difference in elevation from the valley floor to the summits may be as much as 5,000 feet—sometimes even more. Within such an area the weather at any one time will be influenced by many local conditions. Heating of air on sunlit south slopes results in up-slope wind currents; the cooling of air on shaded north slopes produces down-slope currents. The air may be funneled through a canyon, or deflected by a ridge lying at right angles to the wind. Friction slows the movement of air over an old-growth forest, and venturi action accelerates wind blowing through a saddle. Eddy currents form in the lea of a mountain.

Suppose then, the forecast tells you that the air will be moving over such an area at 15 to 20 miles per hour from the northwest and that the minimum humidity of that air will be 30 to 35 percent. It would be illogical to expect all weather observations made within the area to be within these narrow limits. Then how can the forecast be used? Your weather station records can provide the means.

For example, take the typical western area mentioned earlier. Undoubtedly forecasters have been predicting northwest winds of 15 to 20 miles per hour for this hypothetical forest from time to time for many years. Each time that the motion of air across the area was described by the northwest 15 to 20 forecast, the topography probably affected air movement in the same way, reproducing a relatively fixed pattern of eddy currents and other changes over the area. At a particular fire-danger station within the area it is likely that local winds will differ from the forecast in the same way each time this general wind condition exists. At a second station within the area, a still different wind will be observed with the same general flow. Some exposed anemometers in open areas or at stations on high peaks where the flow is little distorted may observe the forecast wind. Now by determining, for selected fire-danger stations within the area, the most likely local wind for any general wind given in the area forecast, you could readily interpret the wind forecasts.

This "most likely" wind may be found by analyzing the fire-weather forecasts made during past years for the area and comparing them with the weather observations made at the selected stations during the same period. For each station make a tally of the winds observed for each general wind forecast (table 1). The tally will show in most cases the station wind that is most likely to be observed for each direction and speed of the wind described in the fire-weather area forecast. Such an aid may be developed for estimating a fire-danger station's wind at the peak of the day's burning conditions from either a morning or the previous evening forecast for the day.

TABLE 1.—*Observed wind speeds for a mountain station in Oregon at time of highest daily fire danger by forecast wind direction* [1] *and speed class*

Forecast wind direction and speed in miles per hour	Observed wind speed							
	0–3 m.p.h.	4–6 m.p.h.	7–9 m.p.h.	10–12 m.p.h.	13–15 m.p.h.	16–18 m.p.h.	Over 18 m.p.h.	Predominant
	Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*M.p.h.*
S.:								
10–12	------	------	------	3	1	1	------	10–12
16–18	------	------	------	1	------	------	------	------
SW.:								
10–12	------	3	7	1	------	2	------	7–9
13–15	------	------	2	4	3	1	------	10–12
16–18	------	------	1	------	------	------	2	------
Over 18	------	------	------	------	------	2	------	------
W.:								
7–9	1	5	3	------	3	------	1	[2] 7–9
10–12	------	1	9	8	1	1	1	7–9
13–15	------	5	17	6	3	1	------	7–9
16–18	------	4	5	------	------	1	1	7–9
NW.:								
7–9	1	3	4	4	2	2	------	[2] 7–9
10–12	1	4	12	------	3	------	1	7–9
13–15	1	6	1	3	2	------	------	7–9
16–18	------	1	2	3	1	------	------	[2] 7–9

[1] Because of space limits, only four directions are shown.

[2] The limited number of observations used in this case does not result in a clearly predominant speed; could be 10–12.

You can apply the same method to observed rather than forecast winds. For example, using winds observed in the morning at exposed peak stations, you will find that for each such observed wind a certain wind will occur most frequently at the usual time of greatest fire danger later in the day. This information can be mighty handy when one morning you find that the wind at peak stations has shifted and increased from the wind of previous days. You wonder: Just what afternoon wind does this morning wind indicate? The station weather records of past seasons can help greatly in making a useful prediction.

In the Pacific Northwest, we have found that similar methods also apply when interpreting the predicted minimum relative humidity in terms of the fuel-moisture reading to be expected on indicator sticks. Each station is different, however, and to date it appears that, as with the wind, this forecast-interpretation aid must be prepared individually for each station.

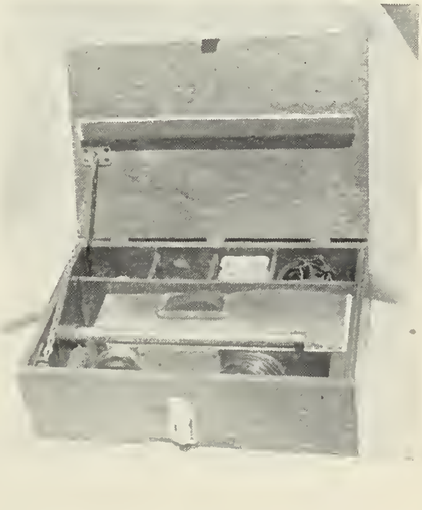
Such aids to interpretation of forecasts are of course not perfect. The forecast is only the best available estimate and shouldn't be expected to be exactly correct every time. Some variation in local effects will occur with similar but slightly different general weather patterns. There will also be occasional periods of exceptional weather. You may sometimes be able to identify these periods as expected distinct exceptions to the rule. Lastly, because of differences in station exposure, the reliability of the aids will vary from station to station. Nevertheless, such aids can give considerable help in estimating burning conditions in advance at individual fire-danger stations.

Successful aids of these types have been constructed for many Forest Service fire-danger stations in Region 6. The process of construction itself has added greatly to the understanding of local weather peculiarities. Laboratory test and field use of the aids have consistently resulted in more accurate numerical estimates of expected forest fire danger.

Protective Carrying Case for FM Handie-Talkie Radio.—In 1949 we had some difficulty in carrying our handie-talkie radios in pickups and jeeps without considerable danger of damage. A leather case was constructed, but it was not sufficiently rigid to fully protect the unit. Therefore, a protective plywood carrying case was devised.

The case is made of one-half-inch Douglas-fir plywood with one-quarter-inch plywood partitions enclosing space for two sets of extra batteries and airplane antenna. The radio is held firmly in place and is supported entirely by sponge rubber. The case is finished with one coat of shellac and two coats of spar varnish. The carrying handle was placed on top of the case rather than on the edge to encourage hauling it in a flat position so that it would not tip over. The lid is fastened with an eccentric hasp-type catch so that it may be locked with a padlock. Materials cost just under $5.

Plans of this carrying case may be obtained from the Supervisor's Office, Harney National Forest, Custer, S. Dak., if desired.—Hugh E. Martin, *assistant supervisor, Harney National Forest.*



NORTHEASTERN INTERSTATE FOREST FIRE PROTECTION COMPACT

R. M. Evans

Executive Secretary, Northeastern Forest Fire Protection Commission

For nearly everyone who will read this article, the disastrous Maine fires of October 1947 have been effectively dramatized by the short motion picture "Then It Happened." The picture is vivid enough, but to have viewed the conflagration from the air while it was in progress, and later the devastated woodlands and farmsteads and villages, was an experience which the writer will not forget.

Fortunately, some good came from all the damage and destruction. First, Maine enacted long-needed legislation to center in the forest commissioner authority over forest fire fighting activities in organized towns, and, second, the Northeastern Interstate Forest Fire Protection Compact came into being.

The Compact didn't just happen over night. Instead, the idea was hammered out in months of discussions which began in the Conference of New England Governors held shortly after the fires. Chief credit for the result goes to a committee composed of the New England and New York State foresters, to which the late John W. Plaisted, of the Massachusetts Commission on Interstate Cooperation, was advisor; to Frederick L. Zimmerman, research director of the New York Joint Legislative Committee on Interstate Cooperation, who prepared the draft; and to the New York office of the Council of State Governments for its guidance and assistance in presenting the Compact to Congress and the State legislatures. It is worthy of mention that representatives of the United States Forest Service participated in the discussions at all times.

Congress passed enabling legislation and six of the seven States ratified the Compact in 1949, the seventh State ratified early in 1950. As far as is known, this sets a record for speed in adopting an act of this kind.

The Compact is quite a document. It is open-ended territorially; that is, any contiguous state or province of Canada may become party to it. It is hoped that the Provinces of Quebec and New Brunswick will join.

The language of the Compact is broad enough to encompass the whole field of forest fire prevention and suppression in the seven States. For example, article I states:

> The purpose of this compact is to promote effective prevention and control of forest fires in the northeastern region of the United States and adjacent areas in Canada by the development of integrated forest fire plans, by maintenance of adequate forest fire fighting services by the member states, by providing for mutual aid in fighting forest fires among the states of the region and for procedures that will facilitate such aid, and by the establishment of a central agency to coordinate the services of member states and perform such common services as member states may deem desirable.

The Compact creates the Northeastern Forest Fire Protection Commission, composed of three members from each State, one of whom shall be the state forester, one a State legislator designated by the committee on interstate cooperation of that State, and one "shall be a person designated by the governor as the responsible representative of the governor."

The commission was organized at a meeting in Boston on January 19, 1950. Perry H. Merrill, State forester of Vermont, was elected chairman and Arthur S. Hopkins, director of lands and forests, New York, was elected vice chairman. Early in May 1950, the writer was appointed executive secretary. An office has been established in the Forestry Building, Laconia, N. H.

The Compact empowers the commission "to make inquiry and ascertain such methods, practices, circumstances and conditions as may be disclosed for bringing about the prevention and control of forest fires, to coordinate the forest fire plans and the work of the appropriate agencies of the member states, and to facilitate the rendering of aid by the member states to each other in fighting forest fires." The commission has the power to recommend to the signatory States any and all measures, legislative or administrative, that will effectuate the prevention and control of forest fires. An important provision empowers the commission to formulate and revise a regional fire plan for the entire region covered by the Compact, which will serve as a common forest fire plan for that area. Furthermore, the commission may request the United States Forest Service to act as the primary research and coordinating agency and the Forest Service may accept the initial responsibility in presenting to the commission its recommendations with respect to the regional fire plan.

The Compact obligates each State to formulate and put into effect a forest fire plan and to take such measures as may be recommended by the commission to integrate its plan with the regional forest fire plan. In emergencies, each State is obligated to render aid to other member States consistent with the maintenance of protection at home.

The Compact solves the difficult problems connected with powers, immunities, liabilities, and duties of State forces rendering aid to another State. It provides that the employees of an aiding State shall, under the direction of the officers of the aided State "have the same powers (except the power of arrest), duties, rights, privileges and immunities as comparable employees of the state to which they are rendering aid."

As to liability, it is provided that no State or its officers or employees rendering outside aid under the Compact shall be liable on account of any act or ommission on their part, or on account of the maintenance and use of any supplies in connection with their mission; and that all liability which may arise, under the laws of either the requesting or the aiding State, or under those of a third State, or in connection with a request for aid, shall be assumed by the requesting State. The aiding State shall be reimbursed by the receiving State for any loss or damage incurred in the operation of any equipment answering a request for aid and for the cost of all "materials, transportation, wages, salaries and maintenance of employees and equipment incurred in connection with such request." However, the Compact provides that the aiding State *may* assume loss, damage, or expense, and may donate services. It was thought that in the case of limited aid donation would be the probable practice, but that in the case of major losses and services it was only fair that the requesting State should be liable for the costs. On the other hand, the Compact provides that each member State shall provide for the payment of compensation and death benefits in case its employees sustain injuries or are killed while rendering outside aid pursuant to the Compact in the same manner and on the same terms as if the injury or death were sustained within the State. To avoid questions of liability which might arise with respect to volunteer forces, the Compact provides that "the term employee shall include any volunteer or auxiliary legally included within the forest fire fighting forces of the aiding state under the laws thereof."

Although it is not expected that the costs of maintaining the commission will be great, provision was made by the Compact for standards in the allocation of any appropriations that may be necessary. It directs the commission to allocate the cost among the States affected "with consideration of the amounts of forested lands in those states that will receive protection from the service to be rendered and the extent of the forest fire problem involved in each state." The commission is instructed to submit its recommendations, based on those considerations, to the legislatures of the affected States.

The foregoing are some of the important provisions of the Compact. There are others.

The policies, plans, and work of the commission still are in the formative state. The Compact was conceived as a means of providing mutual aid in the event of disasters such as the Maine fires of 1947. Provision is being made for that through comprehensive State fire plans prepared from a standard outline, and a regional plan in accordance with which the Laconia office will act as collector and distributor of information about the fire situation in the several States, and as dispatcher in case interstate aid is needed.

But it is believed that the commission's greatest usefulness will be in a general leveling up of competence in the forest fire control field among the member States through such things as the sharing of ideas, training, strengthened legislation, standardization of equipment, and public education. Already closure laws are being studied to see if they may be made more flexible and uniform. The possibility of developing a closure index is being investigated. Uniform training outlines for overhead personnel will be developed and training on an area basis will be stepped up. The place of State forest fire organizations in State civil defense set-ups is being looked into.

All in all, it is the feeling that the Compact provides these seven States with the opportunity to develop an example of unified action in a given field that might well become a model for similar action elsewhere.

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INFORMATION FOR CONTRIBUTORS

It is requested that all contributions be submitted in duplicate, typed double space, and with no paragraphs breaking over to the next page.

The title of the article should be typed in capitals at the top of the first page, and immediately underneath it should appear the author's name, position, and unit.

Any introductory or explanatory information should not be included in the body of the article, but should be stated in the letter of transmittal.

Illustrations, whether drawings or photographs, should have clear detail and tell a story. Only glossy prints are acceptable. Legends for illustrations should be typed in the manuscript immediately following the paragraph in which the illustration is first mentioned, the legend being separated from the text by lines both above and below. Illustrations should be labeled "figures" and numbered consecutively. All diagrams should be drawn with the type page proportions in mind, and lettered so as to permit reduction. In mailing, illustrations should be placed between cardboards held together with rubber bands. *Paper clips should never be used.*

When Forest Service photographs are submitted, the negative number should be indicated with the legend to aid in later identification of the illustrations. When pictures do not carry Forest Service numbers, the source of the picture should be given, so that the negative may be located if it is desired. Do not submit copyrighted pictures, or photographs from commercial photographers on which a credit line is required.

India ink line drawings will reproduce properly, but no prints (black-line prints or blueprints) will give clear reproduction. Please therefore submit well-drawn tracings instead of prints.